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USE OF FILTERS TABLE 4-1

FILTERS	COLOR ABSORBED	NORMAL USE	FILM		FILM TYPE	
			B&W	COLOR	PAN	ORTHO
YELLOW	BLUE	INCREASE CONTRAST	X		X	X
GREEN	RED	INCREASE CONTRAST	X		X	
RED	BLUE & GREEN	INCREASE CONTRAST	X		X	
ORANGE	BLUE & GREEN	INCREASE CONTRAST	X		X	X
80B	COLOR BALANCE	DAYLIGHT TO 3400 FLOOD		X		
80C	COLOR BALANCE	D/L TO WHITE FLASH BULBS		X		
81A	COLOR BALANCE	TYPE B FILM TO 3400 DAYLIGHT TO ELECT. FLASH		X		
85	COLOR BALANCE	TYPE A FILM TO DAYLIGHT		X		
85B	COLOR BALANCE	TYPE B FILM TO DAYLIGHT		X		
SKYLIGHT	BLUE	REDUCE EXCESS BLUE	X	X	X	X
UV HAZE	ULTRA VIOLET	REDUCE ATMOS. HAZE	X	X	X	X
N.D. 4X	NEUTRAL DENSITY	REDUCE FILM SPEED	X	X	X	X
N.D. 8X	NEUTRAL DENSITY	REDUCE FILM SPEED	X	X	X	X
CC30R	BLUE	REDUCES OVERALL BLUE UNDERWATER		X		

1. 52MM THREADED FILTERS TO FIT NIKONOS SUN HOOD.
2. 58MM THREADED FILTERS TO FIT LENS THREAD DIRECTLY. NOT MADE BY NIKON.
3. 58MM FILTERS USED UNDERWATER SHOULD BE INSTALLED SUBMERGED TO FLOOD AIR SPACES.
4. ALL FILTERS SHOULD BE CLEANED AFTER UNDERWATER USE ON ALL SURFACES.

CAMERA CLEAN-UP AFTER USE

It is particularly important to take prompt and complete care of your Nikonos after use in or about salt water. A good diving photographer deals with his cameras, his diving gear and himself in that order after a dive.

Reliable operation of all mechanical devices underwater is more than just important - it could mean your life, if the malfunction was in your breathing device, or no pictures if it is a camera or flash failure. Further, such malfunctions can seldom be properly or even partially repaired while submerged. Therefore, take good care of your equipment.

Wash all of your equipment thoroughly in fresh water after use in salt or dirty water, or where the camera was used near corrosive chemicals in the air, such as near hot mineral springs or industrial processes. If you cannot wash the equipment within a reasonable period after exposure, and the equipment dries, soak the camera and its accessories fully assembled in dive configuration in a sink or bath tub full of warm water as soon as you can. The warm water will speed the dried salt into solution. Warm not hot!

Ordinarily washing under running tap water will scrub away most of the surface salts. Be sure the water reaches every possible seam, recess and blind area where salt residue could be lodged. Dry the equipment by natural evaporation or use a soft lint free towel. Use particular care about the lens glass port as sand lodged in the towel could do considerable damage to the port. Keep the lens cap in place at all times when the lens is out of action, but do not forget to remove it before you dive, or otherwise use the camera, as you cannot tell when the lens is covered as you could with a single lens reflex camera. The Nikonos is a viewfinder type camera.

SECTION 5
FLASH PHOTOGRAPHY WITH THE NIKONOS

The Nikonos is a focal plane type camera with its flash terminals located at the bottom of a threaded cavity on the underside of the outer body. Access to these terminals is restricted to a special connector or adaptor which provides sync to the particular light source used. The Nikonos has its own BC flash unit within the system or a number of other manufacturers make compatible units either with their own connector or a Nikonos cord set. For those using flash above water the Nikonos has a Nikonos to PC cord adaptor which replaces the connector in the terminal recess and adapts the outlet to a standard PC cord outlet. See Section Three for details on the adaptor. ır.

When using bulbs it is most important that you select the long peak type designed for a focal plane shutter. If you use a short or medium peak bulb at high shutter speeds you will produce well exposed partial pictures or no pictures at all as the duration of the flash does not coincide with the sweep of the metal focal plane shutter curtain. Refering to *Table 5-1* you will see how the shutter is synchronized for the various bulb types. "MF" bulbs are the standard flashcube (the new mechanically triggered flashcubes do not as yet have application with the Nikonos). The "M" type is a medium peak bulb intended for use with cameras employing between the lens shutters. The FP bulb is a long peak focal plane shutter bulb designed for use with cameras like the Nikonos.

FLASH BULB SYNCHRONIZATION GUIDE - TABLE 5-1

CAMERA TERM. (1)	FLASH BULB CHARACTERISTIC	CAMERA SHUTTER SPEED					
		500	250	125	60	30	B
FP	M	-	-	-	-	X	X
	FP	X	X	X	X	-	-
	MF	-	-	-	-	X	X
X	X	-	-	-	X	X	X

(1) Refer to Figure 3-1, Section 3, page 3-2.
X Synchronized for this speed.
- Cannot be used at these shutter speeds.

Illustrated in *Figure 5-1* are typical light output characteristics of the flash bulbs shown in *Table 5-1,* and the electronic flash lamp. Your Nikonos has a self-capping focal plane shutter. Such a shutter has two curtains, one released after the other by your initial release then by internal mechanical linkage. The opening curtain uncovers the film as it moves across the aperture, then releases the second curtain at some point in time, depending on the camera shutter mechanism, The opening curtain trips the closing curtain after it reaches a specific point determined by the shutter speed control.

At low shutter speeds, under 1/60th second, the shutter will synchronize with either FP flash bulbs or the electronic flash lamp which reaches its peak almost instantly. At 1/60th second and slower the closing curtain is

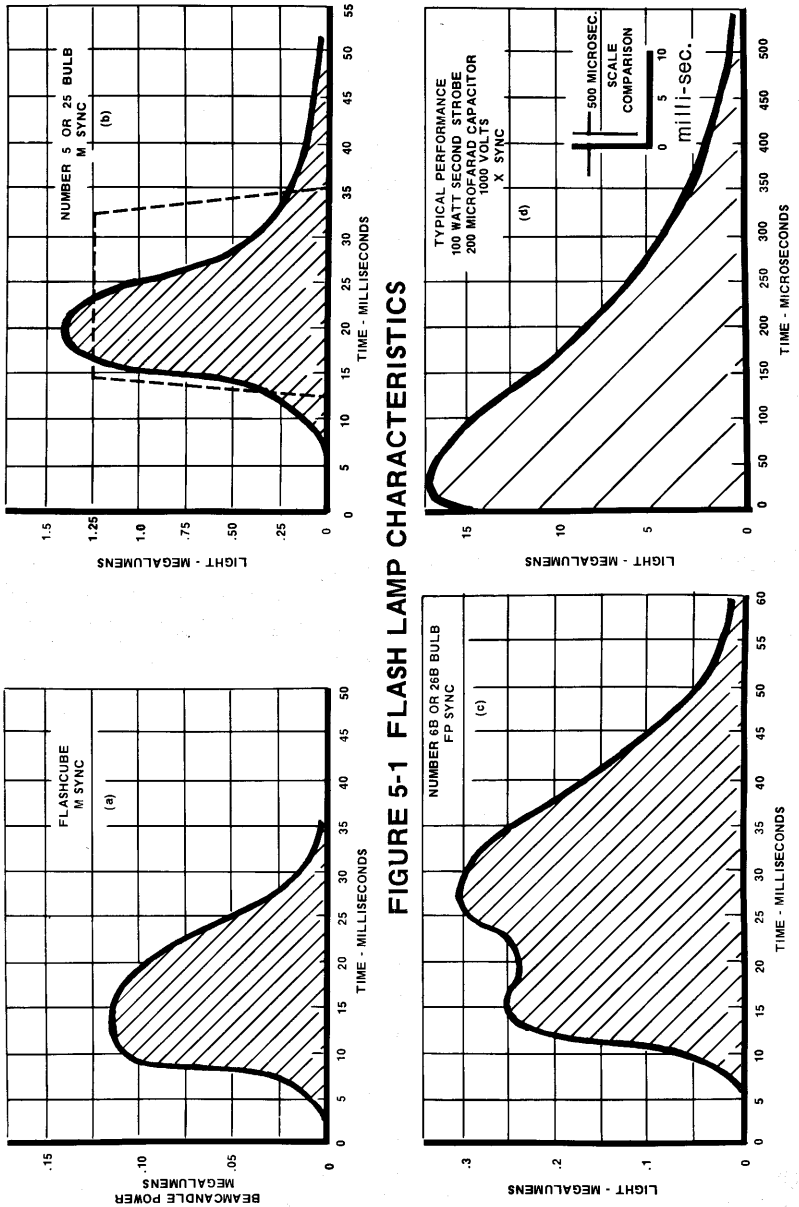

FIGURE 5-1 FLASH LAMP CHARACTERISTICS

Figure 5-1, illustrates the basic curves of time vs light output of common flash bulbs. (a) M Sync Flashcube; (b) M Sync No. 5 or 25 bulb; (c) FP Sync No. 6B or 26B bulb and (d) X Sync Electronic Flash. Curve (d) is time magnified to see curve, see comparison for real size. Curve (b) has 1/50th second shutter action shown, M sync, dash line.

delayed long enough to allow exposure with the M, MF and X sync light sources, but an overexposure or at best an uncontrolled exposure would occur with the FP bulbs as the period of illumination would be almost continuous the whole time the shutter was open, whereas, the exposure with the other lamps is controlled by the peak of the source itself to some extent. Therefore, FP bulbs are not recommended below the shutter speed of 1/60th.

Using flash bulbs for illumination with a focal plane shutter can be a problem if you use one whose light characteristics do not match that of the camera shutter, refer to *Figure 5-2.* However, flash bulbs do not all produce the same amount of light either, see *Table 5-2.* Comparing the table and the figure you can see that the no. 6 focal plane FP bulb reaches peak illumination sooner than the no. 5 and stays at peak for an extended period of time. This is necessary as the film is swept by the two curtains of the shutter. The no. 5 bulb starts to peak later than the no. 6 and does not dwell, but diminishes rapidly. This is an M sync bulb designed for shutters that operate between the lens - a Compur or similar type. These shutters have a built-in delay for the shutter to reach proper speed so the actual exposure occurs during the peak of the bulb. The focal plane shutter generally will not yield full frame exposures if M sync bulbs are employed above 1/30th of a second, refer to *Table 5-1* for further Nikonos shutter sync data.

STANDARD FLASH LAMP CHARACTERISTICS - TABLE 5-2

FLASH TYPE	LIGHT OUTPUT LUMEN SEC.	APPROX. PEAK LUMENS	APPROX. TIME TO PEAK MILLISEC.	APPROX. DURATION AT ½ PEAK MILLISEC.
MF Flashcube	2,000 (1)	130,000 (2)	13	15
M no. 25B	10,000	760,000	20	14
FP no. 26B	9,800	270,000	-	24
X Electronic	1,200 (3)	-	0.6 (1/1500)	-

(1) Beam candle power seconds BCPS built-in reflector.
(2) Peak beam candle power.
(3) Varies from mfg. to mfg., values shown are for Honeywell 65A at 40 watt seconds stored energy, beam candle power seconds BCPS. Built-in reflector.

Use focal plane FP bulbs with your Nikonos. These bulbs will synchronize with all but the very lowest speeds of your shutter and in the long run will cause you far less partially exposed or incorrectly exposed photos. You are interested in getting results not how to outsmart your camera so play the rules.

Sometimes, even when you seem to have done everything correctly, the camera may still fail to give you the results you wish. In *Table 5-3,* on the following pages, an analysis is made to help you locate and correct problems that do arise now and then with any camera, but in particular the table is oriented to your Nikonos.

TROUBLE SHOOTING THE NIKONOS CAMERA - TABLE 5-3

RESULT	*POSSIBLE CAUSE*	*CORRECTIVE ACTION*
Well exposed, but partial picture (Horizontally divided).	1. Wrong type of flash bulb. 2. Electronic flash at shutter speeds faster than 1/60th second. 3. Flash adaptor (if used) has wrong sync position, or has moved since original setting. 4. Defective or wrong contact in BC camera connector - see *Figure 3-1,* this figure shows the end of the flash adaptor, but the end of your connector should be similar.	1. Use FP type bulbs or correct speed. 2. Use 1/60th or 1/30th second. 3. Adjust adaptor so colored dot shows red for FP or black for X sync. 4. Replace flash cable or take the camera to a Nikon repair station and have the contact moved to the proper location.
Long black spaces in exposed processed color film or long clear spaces in exposed processed B&W film.	Moving film advance lever, but not to cocked position. Safety lock kept lever from latching, advancing film, but not counting or cocking the shutter.	If you do not wish to space without counting, move the safety cam out of the way of the cocking-release lever.
Film did not advance upon loading new cassette, processed film all black (color) or all clear (B&W).	1. Left lens cap on during exposure. 2. Leader not caught by tooth in slot in sprocket hole or leader sprocket hole stripped and film slipping on take-up spool.	1. Always remove that lens cap! 2. Follow loading sequence correctly. Make sure the leader does move by slight action of the cocking-release lever, while you watch the film. The same thing happens once in a while with a regular 35mm camera, but here you can usually tell that the film is moving by watching the knob above the cassette - it too moves with the film, not so the Nikonos.

RESULT	*POSSIBLE CAUSE*	*CORRECTIVE ACTION*
Film has long scratches running horizontally across slide or negative.	1. Dirt or scratches on pressure plate. 2. Dirt or nick on edge of aperture mask. 3. Film rewound too tight in cassette.	1 & 2 Examine and polish. Replace pressure plate. Needs expert repair. 3. On rewind film leader will not disengage with tooth in slot, forcing this may (1) damage the take-up lever or gear train, (2) cause film scratches due to tight wind in cassette. If you feel considerable resistance at the end of rewind, open the camera in a darkroom or camera change bag - do not force.
Film advance shutter cocking lever will not move.	Roll of film has been fully exposed and you have reached the last sprocket hole Forcing the lever in may (1) pull the film free of the cassette or (2) damage the mechanism or (3) tear-out the sprocket hole in the film.	Return to the surface and rewind. It is not necessary or even desirable to rewind underwater since you cannot remove the film until you surface.
Rewind lever will not retract after rewind.	Will not disengage from rewind gear.	Be sure the lever is retracted *BEFORE* loading a new roll of film. Hold the cassette spool fork with one hand and carefully rock the rewind lever back and forth as you push it back into the inner body. A partial turn of the crank may be necessary to disengage the gear.
"0" ring damaged.	Sand, dried salt, improper handling.	Replace at once.

Continually cutting off subject when working at low end of focus range.	Parallax.	Use parallax correction frame in optical finder. Tilt the camera upward and to the left with sportfinder after framing. See *Figure 1-17.*
Flash bulb will not go off.	1. Battery dead in BC flash unit. 2. Corroded BC flash outer contact. 3. Bent contact either inside camera or where connector engages. 4. Defective flash bulb, try several before giving-up! 5. Poor connection in the electronic flash sync cord plug outlet.	1. Change the battery. 2. Clean stainless steel plunger with fine sandpaper, wash with water to remove sandpaper grit . 3. Surface, open camera, clean contacts, wash off dirt with alcohol not water. 4. If everything seems to be in order try a flash bulb substitute (small light bulb in a special socket or use a voltmeter. If all check well try another flash bulb. 5. It sometimes helps to bend the cord terminals to insure good contact inside the flash socket. Do not over bend as you can force some terminals back into the body creating a new problem.
Illuminated area of flash not where subject is located.	Aim of reflector incorrect.	Place yourself in front of the camera where the subject would normally be - is the reflector pointed at you? If not, adjust the aim until you are sure it is aimed properly.

Picture is exposed, but too dark (color) or too light (negatives).	Check your bulb guide number. Check your shutter speed. Check your f/number. Check lens for filter.	Recompute exposure or make a test series of exposures to correct the flash guide number to your particular usage. See text for method.
Picture exposed, but too light (color) or too dark (negatives).	See item above.	See item above.
Seals dry.	No lubrication.	Grease with Nikonos "O" ring grease, petroleum jelly, barium "O" ring grease or silicone grease as last resort.
Lens fogged, inside front port or rear element.	Leak in lens.	Take to camera repairman at once, do not try to disassemble.
Lens scratched, outside front port or rear element.	1. If not visible on photos. 2. Visible in photos.	1. No action necessary, a scratch in the right place may not be visible, therefore, no need to correct. However, find out how you made the mark and do not repeat! 2. Element must be replaced or more distortion may occur, if improperly reworked, than the original mark.
Pictures blurred.	1. Too slow shutter speed - camera or subject motion during exposure. 2. Forgot to set focus control. 3. Using close-up attachments or extension tube.	1. Increase shutter speed. 2. You must manually focus as you are not looking through the lens as in an single lens reflex (SLR). 3. Check distance to subject, frame use the Lens Focuser described in the text.

EXPOSURE

Underwater or surface exposures are best determined with a reliable exposure meter. Whether you use the selenium cell or a cadmium sulfide photo resistor type meter is not too important, though the latter is much more sensitive. Use the reflected light meter if you take your readings from the camera toward the subject, or the incident light type if you take your readings from the subject toward the camera. Underwater the incident meter is not so practical as your subject may not cooperate, nor are the readings likely to be as usable as a narrow acceptance angle reflected light meter. Most meters are of the reflected light type.

Underwater the reflected light meter is preferred. The selenium photo cell unit does not need a separate battery and does not need an external switch to activate the meter. The meter can be direct reading, giving you your f/number directly for the preset film speed or it might require that you compute the exposure from a scale using needle matching or dial movement.

Available light photography underwater is not quite the same as on the surface, unless you try your hand on a foggy day. This is not the best comparison, perhaps, but accurate enough for the purpose. Many people dive where the water is not perfectly clear or the bottom light colored, or where the water is still. All of these factors contribute to general turbidity and the foggy day effect.

Light from the sun arrives on the earth in the form of waves or bundles of rays, whichever you prefer, traveling in a straight line. Each ray strikes an object on the earth and either goes on through the medium, is bent off its path by the medium, is reflected away from the medium or it is absorbed in the medium. Light strikes the canopy of air blanketing the earth and is affected in all of these ways depending on what angle the ray strikes the air envelope, or what it intercepts on it's way to the earth. Clouds, haze, water vapor, dust and many other things in the air affect the path of the ray.

Light reaching the surface of the water is generally reflected, refracted or absorbed. In the latter case the absorption occurs as the ray travels down into the depths or is scattered by suspended matter in the water. Light that is reflected from the surface of the water is of no practical use to the underwater photographer as it is lost for his purpose. Only that which enters the air-water interface by direct transmission concerns him.

The light entering the water is bent from its original path due to the denser medium (water is more dense than air). The further the sun from the zenith (directly overhead) the more light is refracted until a point called the *critical angle* is reached and all of the light is reflected back into the air rather than entering the water.

For the available light photographer 10A.M. to 2 P.M. is the best time of day to work as the most light reaches the bottom or at least is traveling through the water past the subject. From 8 A.M. to 10 A.M. and from 2 P.M. to perhaps 4 P.M. are fair depending on the water conditions in the area.

Best results will be acheived with a minimum amount of water between the subject and the camera lens. The clearer the water the better chance for good distance pictures, but the filtering effect of the water soon takes its toll in contrast and sharpness. It is harder to get accurate meter readings

on distant objects because the light is scattered by small suspended particles in the water. Sometimes it helps, except near a light colored bottom, to angle your meter slightly downward from the surface when taking readings.

Placing a flat black painted tube, like a baby food can, with its ends removed, over the cell aperture helps as this reduces the underwater diffused light from indicating greater brightness than really exists.

Closer-in the meter begins to act more like it would on the surface. You can always use your own hand for a reflecting surface if you cannot approach the subject, but the results, underwater, will not be as accurate as it would be above water, unless the water was exceptionally clear. Do remember that many underwater subjects are dark or matte textured and do not reflect as much light as their counterparts in the air, so it may be necessary to open your lens a stop or so to compensate. Experience is your best guide in this area. Do not be afraid to waste a few shots by experimentation.

Color film and available light have a few more problems than B&W film. Light striking the surface and entering the water is what we call visible or white light. Your film is balanced for that type of illumination if it is daylight type. However, water is a selective spectral filter and absorbs some visible wave lengths faster than others at given depths.

The color red, for example, is filtered from the white light wave front, by the water, very rapidly and is almost non-existent at 30 feet. This leaves the photographer with blue and yellow (green) pictures quite a distance into the depths. The clarity of the water and the type of suspended material will determine whether the more prominent characteristic color is more blue or more green. Even very colorful subjects look quite different when illuminated with blue, yellow or green light.

It does help to put a blue absorbing filter on your camera to reduce the overall bluish look. For B&W film the yellow, green, red and orange filter will help. The yellow K2 or the orange are the most commonly used to improve the contrast. For color film your Nikon CC30R filter is preferable. The blue absorbing filter can be screwed into your Nikonos lens hood, & the hood can be in turn screwed into the front of any of the Nikonos lenses whenever available light pictures are to be taken. Do not use the CC30R over the lens when using flash as the major light source as the flash is balanced to match the color temperature of the film without the CC30R in the light path. If the flash is used as a secondary or fill-in light for available light pictures, it is acceptable to have the CC30R over the lens.

COMPENSATE in your meter setting for the filter factor, as some useable light is absorbed in the filter and this reduces the effective exposure of the film. *Table 5-4* lists typical filter factors for common filters that you might use with the Nikonos. Always refer to the manufacturers literature packed with your accessories for exact values for that particular unit. To get a new corrected or effective film speed divide your ASA film speed by the filter factor or convert to stops and adjust the light reaching the film by opening the aperture. If you are using a meter the new effective ASA speed is preferred as you may forget to make the f/number adjustment, whereas the meter set to the effective film speed will give you the proper f/number-speed relationship without additional confusion.

Table 4-1, indicates which filters are used for B&W film, which for color film and which filters are used with either B&W and color film. The last column in *Table 5-4*, lists a value called the *mired number*, and this value is a useful device to match the film, light source and filter to obtain correct color balance when using color film and artificial light sources. *Table 5-5*, should be used in conjunction with *Table 5-4*.

Table 5-5, lists some of the more common film types and light sources along with the mired number of each. To use the mired system to balance your film to your light source simply *subtract* the mired number of the light source from the mired number of the film. The result is the mired number of the filter required. Use care in the process and do observe the sign of the numbers. A plus number less a minus number becomes larger as a minus and minus is a plus. Refer to the examples following the tables.

ARTIFICIAL LIGHT PHOTOGRAPHY WITH THE NIKONOS

The mired system of arriving at color balance between film and light source, described in the two tables following this section, is particularly useful for artificial light situations, in fact this is where most of the color imbalance occurs in actual practice.

Flash bulb and electronic flash are the key illumination sources for the still photographer underwater. The flash bulb is particularly very portable, simple to use, fairly foolproof and inexpensive –considering the cost of everything else the underwater photographer has on or is using.

The electronic flash eliminates the "used" bulb problem, the "lost bulbs in the surf entry" problem and is, in the long run, the lowest in cost. This type of light source is a little harder to manage, and usually has a little shorter range. The electronic flash user must be a little more careful to use correct guide numbers and to aim his unit properly.

Flash bulbs that are dyed blue approach daylight in color balance, while the electronic flash lamps vary and are sometimes more blue than most daylight color films are balanced to use. This is more evident when you are working close to your subject. Color temperature of electronic flash units can be found to vary from 6000 to 7000 degrees K (Kelvin), one brand to another, not the same flash unit. Most daylight color films are balanced for 6100 K, *Table 5-5*. The excessive blue, if present, produces a coolness in the results that is not pleasant to look at when you know the real colors are warm and pleasing to look at.

The Nikonos user can select the accessory BC (Battery-Capacitor) flash unit built for the Nikonos or purchase quite a variety of non-Nikon accessory flashes including a number of electronic flash units with the required special Nikonos connector and X sync. Each type will be discussed as it applies to the Nikonos.

BC FLASH

The BC flash unit is a device which increases the firing energy of the battery to overcome contact resistance and corrosion in the flash circuit. Most flash bulbs will fire with as little as 3 volts if the circuit is sound. Underwater photographers over the years have found that after a while the flash circuit is anything but sound. Contacts become corroded, wires are

TABLE 5-4
FILTER CHARACTERISTICS, MIRED NUMBERS

FILM	FILTER TYPE	FILTER FACTOR	STOPS TO OPEN	MIRED NO.
B&W	YELLOW K2	2	1	
	RED A	8	4	-
	ORANGE G	2.5	1¼	-
	GREEN 1	6	3	-
COLOR	80B (1)	2	1	-90
	81A (2)	none	-	+18
	81C (3)	none	-	+35
	81D (4)	1.7	¾	+45
	82A (5)	none	-	-21
	85 (6)	1.5	2/3	+110
	85B (7)	1.5 (8)	2/3	+130
	CC30R	6.2	3	-
BOTH	HAZE	none	-	-
	SKYLIGHT 1A	none	-	-
	N.D. 4X	4	2	-
	N.D. 8X	8	4	-

(1) Daylight Kodachrome II, Ektachrome, Anscochrome, High Speed Ektachrome with 3400 K flood lamps.

(2) Daylight Kodachrome II, Ektachrome, Anscochrome, High Speed Ektachrome with electronic flash. Type B Ektachrome and High Speed Ektachrome with 3400 K photoflood

(3) Type A Kodachrome II, Ektachrome B, High Speed Ektachrome B with clear flash lamps (except SM or SF).

(4) Super Anscochrome T with clear flash lamps (except SM or SF) Also same film as 81C with somewhat warmer results.

(5) All daylight type films, including Kodacolor, Ektacolor and Agfacolor CN14 and CN17 in early AM or late PM to reduce reddishness of the light. Also with Type A films for shooting under 3400K Photoflood lamps.

(6) Type A Kodachrome II and Anscochrome with daylight.Also haze filter at same time when used with above film.

(7) Super Anscochrome T, Ektacolor L, Type B Ektachrome and High Speed Ektachrome with daylight. Also haze filter at same time when used with the above film.

(8) Underwater rating by Tiffen Filter data.

FILM & SOURCE CHARACTERISTICS - TABLE 5-5

FILM OR LIGHT	COLOR TEMP. K	MIRED NO.
EKTACHROME	6100	+170
KODACHROME II & X	6100	+170
H.S. EKTACHROME	6100	+170
KODACOLOR X	6100	+170
AGFACHROME	5500	+180
KODACHROME TYPE A	3400	+290
ANSCOCHROME	6000	+170
EKTACHROME TYPE B	3200	+310
500W PROJ. LAMP	3175	+320
3200 PHOTO LAMP	3200	+310
FLASH BULB - WHITE	3800	+260
FLASH BULB - BLUE	6000	+160
FLASHCUBE	5500	+180
ELECTRONIC FLASH (1)	6500 ave.	+150

(1) Check your particular brand mfg. instructions sheet for data.

EXAMPLES MIRED CALCULATIONS

Problem: Ektachrome X film, mired no. +170 (Table 5-5), 6100K. white flash bulbs, mired no. +260 (Table 5-5), 3800 K.

Film mired number +170
Light source − (+)260
− 90 mired

Look in Table 5-4, filter 80B has a mired value of −90.

Problem: High Speed Ektachrome film rated ASA 400 (ESP-1 processing), processing does not alter mired rating of +170. Electronic flash with color temperature of 6500 K, mired value from Table 5-5 is +150.

What filter is required to use this combination?

Film mired number +170
Light source − (+) 150
− 20 mired

Look in Table 5-4, filter 82A has a mired value of −21.

If the electronic flash unit above had an output color temperature of 6000 K in place of 6500 K, the mired value would have been +170, and no filter would be required. The need for a filter for the above flash with only an out of balance of 500 K would probably be most noticable when the subject is at close range. If the results appear cool or bluish, a filter will shift the color to its normal value.

eaten up by the sea water and the flash unit just is not reliable. With higher energy, which the BC unit produces, the system will function more reliably for longer periods of time. Refer to *Figure A-1,* page A-6.

The extra energy or "kick" can cause some flash bulbs to explode outside of the water, if the protective plastic shield encasing the glass envelop is loosened by submersion. For safety sake these bulbs should not be used above water. Carry only as many flash bulbs as you intend to use on your dive, with maybe a spare or two in case of misfires. Underwater flash bulb implosions (inward explosion) are not uncommon, and except for a brief small pressure pulse or bang, they are not hazardous to the diver. One is well advised, however, to wear at least one leather palmed glove to remove spent bulbs, regardless, as once in a while a bulb will crush or snap off where the envelop joins the base as you remove it from the reflector.

The Nikonos BC accessory flash unit has a very simple and easy to operate bulb ejector which does not require hand contact with the glass envelop of the bulb. If you do not wish to litter the upper or lower world with your spent glass you will have to catch the floating bulb as it is released. Few divers worry about these spent bulbs, but very nasty cuts have been sustained by people on the beach who have stepped on one of them. A floating beer can or flash bulb is litter any way you look at it.

To take flash pictures with your favorite film, and it is a good idea to settle down with one or two types of B&W and color film, you must match your flash bulb light characteristics to that of your camera shutter. Your Nikonos is a focal plane shutter camera and will give you the best results with FP long peak bulbs. Then match your bulb color temperature to the film color temperature or balance and you are ready to get down to business.

Each flash bulb or electronic flash unit manufacturer provides literature with his material or equipment to help you determine the proper f/number to match your film speed and select the required shutter speed. The mathematical device that is most commonly employed is called the *guide number.* This number represents the product of the required f/number and the distance to the subject in feet. Reproduced in *Table 5-6,* is the information found on the back of the carton of 26B blue flash bulbs and *Table 5-7,* the same information from the back of the carton of 5B bulbs. The former are used for the focal plane shutter, like the Nikonos, and the latter for the between the lens shutter like the Rollei 2¼ square camera.

This data is given to the user as a guide and will vary from one bulb brand to the next. Further, the numbers given will give different results to different photographers because of equipment variations like reflector reflectivity. If you use the Nikonos BC flash unit and find that a particular guide number is satisfactory, you can be reasonably sure that another user with the same basic type of flash unit will also have good results under the same conditions. Someone else, on the other hand, using a polished reflector or no reflector at all will not find the guide number to work well under the same circumstances. You must fine tune your own equipment to your own waters and subject matter for best overall results.

If you were to use the data in *Table 5-6* to take photos with your Nikonos in air, the numbers shown will be reasonably accurate if you consider the reflector used and make proper corrections for reflectivity. To

find your f/number for a given film and shutter speed, (you have FP sync at all speeds from 1/60th to 1/500th second with the Nikonos) first find your ASA film speed along the top of the table. Follow this column downward to intercept the horizontal line represented by your shutter speed, where the vertical column intercepts the horizontal line the guide number of the bulb is shown.

Table 5-7, on the other hand, is not intended for the Nikonos user unless this type of bulb is all that he can secure in an emergency. In this case he must set his shutter speed at 1/30th second if he wants results. The "B" suffix on the number indicates a blue dyed bulb to be used with daylight color film. The bulb can also be used for B&W film, but it usually costs more than the white bulbs, so it is better to use it only with color.

USING THE GUIDE NUMBER

To find the best f/number to use with a given flash illumination source it is only necessary to divide the guide number by the distance from the lamp to the subject in feet. If you prefer to work in metric units it will be necessary to make a new guide number table similar to either *5-6* or *5-7*, divide all of the guide numbers shown by the factor 3.28 (there are 3.28 feet in each meter). The resulting number is natually about 3¼X smaller than those shown, but if you then divide these by the distance from the subject to the lamp in meters you will obtain the very same f/number as the table guide number divided by feet. The examples are done in the more familiar (in the U.S.) English system, directly from the table values.

FP BULB GUIDE NUMBERS (26B) - TABLE 5-6

SHUTTER	FILM ASA SPEED - GUIDE NO.					
SPEED	10-12	16-20	25-32	40-64	80-125	160-200
up to 1/30	65	85	110	150	200	260
1/125	32	40	50	75	95	130
1/250	22	28	36	50	70	90
1/500	16	20	26	36	48	65
1/1000 (1)	11	14	18	26	34	46

(1) Speed not available on the Nikonos.
(2) Guide number shown is approximate
(3) Nikonos is synchronized for 26B bulb from 1/60th to 1/500th.
(4) Guide numbers for 4-5 polished reflectors; open ½ f/stop for others.
(5) Balanced for average color film response.

EXAMPLE - GUIDE NUMBER CALCULATION

(1) Film selected for example is Ektachrome X daylight, ASA 64. Flash bulb is a blue number 26B. Shutter speed of 1/125th second. Subject distance 10 feet.

To find guide number refer to *Table 5-6.* Enter table horizontally at the shutter speed at 1/125. Enter the column vertically at the film speed ASA 64. Read the guide number 75 where the column and row intersect.

To find f/number, divide the guide number 75 by the distance from the subject to the lamp 10 feet.

$$f/number = 75 \div 10 = 7.5$$

Now you will be hard pressed indeed to find f/7.5 on your camera lens scale so go to the nearest whole f/number or f/8. You could guess the location on the scale where the odd f/number would fall, but for all practical purposes the exposure latitude of the film will handle the small error. Further the number may represent a flash reflector that is not quite identical to yours so you will need corrected guide numbers to match your own flash reflector and photographic conditions if you have a critical color application. Color film has an exposure latitude, room for error, of about one stop while B&W film will allow an error of about two stops. For flash use underwater you will need a few test exposures regardless to zero-in on an approximate guide number so you will arrive at a reflector correction at the very same time with no additional tests. More on this when we discuss your Nikonos underwater with flash.

As you settle on your preferred film and bulbs you should fine tune the guide numbers to your particular need or taste in color saturation or negative density. You will discover soon enough that the guide number for bright light colored subjects or areas is not quite the same as for dark colored subjects or areas. You might even discover that the guide number will vary some as your batteries run down.

Regardless of the little variables that make the exposure just a bit more complicated, the guide number method of determining exposure is the most reliable, consistant, powerful tool you have in your favor.

One other subject needs mention at this time - exposure for two or more sources of light at the same time. Suppose both available and artifical light are acting on the subject at the same time. To determine which light source is the main or key light you must compute the f/number for each and compare the results. You will expose for the most dominate of the two sources. If, for instance, you took a meter reading and the meter indicated that for this film and shutter speed and particular lens to subject distance the f/number should be f/16, you also are using flash and via the guide number you find the f/number should be f/11. The smaller iris opening, f/16, tells you that the available light is brighter than the flash and is thus the dominate light source.

On the other hand if your calculations using the bulb guide number indicate that that is the smaller opening of the iris, the flash is the dominate source and that f/number should be employed.

If you use more than one flash unit at the same time, the result is not necessarily twice as much light! A series of test exposures is the most ready means of solution, but for electronic flash, one of the new flash meters can save considerable time and money through reduced film and

M BULB GUIDE NUMBER (5B) - TABLE 5-7

Exposure information for No. 5B flashbulbs, 20 millisecond time to peak. For B&W or daylight color films

	FILM TYPE	GUIDE NO. FOR POLISHED REFLECTOR (1)					
		1/30 or slower (2)	1/50 1/60	1/100 1/125	1/200 1/250	1/400 1/500	ASA SPEED
DAYLIGHT COLOR	ANSCOCHROME 50	150	130	115	100	80	50
	ANSCOCHROME 100	220	185	175	150	110	100
	ANSCOCHROME 200	300	250	230	210	160	200
	EKTACHROME X	175	150	140	110	90	64
	H.S. EKTACHROME	280	230	210	180	150	160
	KODACHROME II	110	95	90	75	60	25
	KODACHROME X	175	150	140	110	90	80 (3)
	EKTACOLOR S	175	150	140	110	65	80 (3)
B&W	PANATOMIC X	140	120	115	100	80	32
	PLUS-X PAN	250	210	195	155	125	125
	TRI-X PAN	440	370	350	300	230	400
	VERICHROME PAN	250	210	195	155	125	125

(1) For diffused or folding reflectors open 1 lens stop or multiply guide number by 0.7.

(2) Synchronized for X, F, M, or FP this shutter speed only.

(3) Rated by this manufacturer the same as Kodachrome X, speed is close enough so that this is reasonable assumption.

processing cost. Bulbs will work also with some of the new meters, but each flash with a bulb costs the price of the bulb, whereas, a flash from a strobe costs practically nothing over the life of the units.

UNDERWATER FLASH WITH THE NIKONOS

Underwater with your Nikonos and accessory BC flash unit the guide number of the bulb manufacturer takes a nasty slump. The table guide number now will not give accurate results and the color of your subject becomes much more important. Through experimentation you can find a common denominator to the underwater guide number problem and this is a correction factor that accounts for the added filter factor of the underwater medium - dirt and water, sand and water or whatever you have in the water of your locality. The new medium (water) is not as clear as air, but rather absorbs and scatters light along the path from the bulb to the subject and from the subject to the lens.

Most underwater photographers seem to settle on several, not one, correction factors and these factors seem to hold fairly well for most types of flash - bulbs or electronic discharge tube and at any shutter speed

where characteristics match. The guide number correction factor is dependent on the distance of the flash to the subject as before. When the unit is from 2½ to 3 feet from the subject divide the manufacturers guide number by 4; when the subject is from 3 to 10 feet divide the surface guide number by 2½. You may find that in your particular water that you need something in between, say 3 to 6 feet, and a factor of 3 is probably a good starting point for your test pictures.

For best results with underwater flash, begin by shooting a test roll of your preferred film and necessary flash bulb of the correct color balance. Use the factors given above as your starting point, then bracket each exposure by one or two stops, keeping accurate records of what settings were used and the distance estimated to the subject. When the results come back from the processor, select the pictures that are properly exposed and compute the guide number that this exposure represents by multiplying the f/number by the distance. Using estimated distance is usually preferred, except for very close photos, as you seldom have the time or means to measure distance in real life picture situations. Be sure to shoot pictures at a variety of distances so that you have a reliable guide number for the type of water and distance you intend to work.

Keep accurate and complete records when making test shots. Memory is is not always as good as we would like it to be, and sometimes just a little thing, like the color of the subject or background, can mean the difference between a properly exposed picture and one that is over or underexposed. Keeping a photo log book is particularly important at the beginning of your career, but the habit will always be an asset.

If you plan to work very close to subjects a new set of corrections may be in order. In the case of extension tubes a *Bellows* factor must be considered. See section 6 on close-up photography with the Nikonos for full information on how to determine and adjust for close-up lenses and accessory lens estension tubes.

Black and white film guide numbers can be found about the same way as those already described, assuming the tests above were made with color film. Another important factor enters the scene for B&W film that is not too variable in the case of color film, that is film processing. Color film processors are extremely careful to control the whole color process, good final results depends on this control. Most commercial color labs do this with great care and repeatability. The B&W process, on the other hand, can use a great variety of chemicals, temperatures and times on the same given B&W film and each produces slightly different density, gamma or contrast results in the final negative.

When establishing a guide number for your preferred film, and Kodak Plus X pan is a good choice, begin your first underwater roll with a selected few *topside* subjects of known tone value, exposed at correct shutter speed and f/number, so you have a point of reference to judge the quality of those first underwater shots. Take a few bracket shots of one to two stops over and under the estimated exposure. Later when you do the same thing underwater you have a good comparison for general contrast and density. Do not alter your development method or laboratory in these test rolls until you have established a good guide line.

With your Nikonos you can apply different filters on the lens while underwater. Do use these filters also in your testing plan. Compensate for the absorption of the particular filter in your exposure. The result on these negatives will give you a first hand comparison with non-filter negatives so that you know if you are getting what you want in penetration and contrast. After you have a grasp of camera handling and regular exposure, you may wish to try further negative control as obtained by selective exposure and modified development of the film.

The serious underwater B&W photographer will at least process his own negatives as he then can control the most important step beyond exposing the film itself. Any camera store can start you in the right direction with reference material, chemicals and basic equipment. A few of the very basic items of equipment and chemicals for B&W processing are shown in *Table 5-8-*

It is not suggested that you start out developing your own color film as, everything considered, it will probably cost less to have a laboratory do it for you. Developing color film is easy, but requires much more precise controls than B&W film and the chemicals are expensive, have a short shelf life and the temperature-time relationship is very critical. The process also takes much, much longer than B&W. B&W film can easily be developed and ready to dry in as little as 20 minutes, depending on the developer and fixer you select to use and whether you use a tray or tank method.

ELECTRONIC FLASH

The Nikonos has a focal plane shutter which sweeps the film during the period of exposure. If you used an electronic flash at a shutter speed above the recommended 1/60th second, you take the chance of producing a well exposed partial picture or no picture at all.

The reason an inaccurate exposure occurs is the duration of the light pulse produced by the discharge of a bank of capacitors, at very high voltage, into a gas filled tube. The speed or duration of the ionization and deionization of the gas can be anywhere from 1/500th second to 1/10,000th.

At 1/60th second or slower (not *R* setting!) your Nikonos opening shutter curtain or blade has fully opened the film aperture and has just tripped the closing curtain. The momentary electronic flash now exposes the whole frame of film and you generally do not care about the rest of the closing curtain travel making up the balance of the 1/60th second. Beware, however, of double exposure when using high speed film and electronic flash in bright daylight. Here you can get two distinct exposures, one with the flash and a second with the available light. To avoid this try to use small iris openings, large f/numbers, and hold the camera very steady.

Underwater the 1/60th second shutter speed combined with a 1/1,000th or so electronic flash period is a good situation generally, no double exposure and the subject is *frozen* due to the very short flash. If you want intentional blur with electronic flash, change from fish to the wings of a hummingbird.

The guide number for your particular electronic flash unit can be found either as data in the instruction booklet packed with the flash, or as a computer dial on the flash unit itself. To establish a basic datum

line with new equipment, set the computer to the selected film ASA speed, read the f/number nearest the subject distance & multiply the two values together. The number that results is the familiar guide number. Record this value in your log book and shoot a few experimental photos using the same factors mentioned earlier as underwater correction factors, or use the result of your own BC flash test rolls. Do bracket these test photos as some adjustment may be necessary because the reflector is not the same nor the angle of the light beam. Again compute a new guide number from the actual results and use this in future similar shots.

B&W FILM PROCESSING
BASIC EQUIPMENT AND CHEMICALS - TABLE 5-8

BASIC EQUIPMENT

1. Plastic or stainless steel daylight developing tank to fit your film size. The Nikonos uses 35mm film. The Ansco *Anscomatic* tank is recommended for a good multipurpose B&W or color tank and the *Nikor* stainless steel tank and reel for 35mm will last a lifetime with a little care.
2. Glass graduate, 32 ounce.
3. Funnel with a stainless steel screen.
4. Stirring rod - glass, plastic, plastic coated metal or stainless.
5. Thermometer - 0 to 150 degrees F.
6. Film clips (two required per roll), clothes pins will also work.
7. Four plastic or brown glass or plastic bottles with sealing caps, select a size to match your chemical batch size like 1 pt. or 1 qt.
8. Daylight film change bag - if you do not have a darkroom.

BASIC CHEMICALS

1. Kodak Microdol-X developer (low graininess).
2. Agfa Radinal (1 use liq. concentrate) developer, ultra-fine grain.
3. Acufine developer, replenisher type, increases ASA speed, fine grain. Available as dry powder.
4. Kodak acid fixer (10 minute fix), sometimes referred to as *Hypo.*
5. Kodak Rapid acid fixer (2-3 minutes fix), alternate to item 4.
6. Kodak Hypo clear (saves wash water and time after fixing).
7. Kodak *Photoflow*, film wetting agent to reduce water spotting.
8. Plenty of running water, 80 degrees F. or lower.

The use of flash underwater will generally settle down to a narrow range of subject distance due to the water clarity. Seldom must you remember too many numbers or factors to get results. It does help, however, to select a specific type of film and stick with it to eliminate a new set of factors until you gain confidence in your equipment and techniques. Do not

be afraid to waste a few shots experimenting. Experimentation in the long run, will save many priceless pictures and even reduce your picture unit cost by resulting in more good shots per roll.

Table 5-9 illustrates that the electronic flash unit requires more care than bulbs as no two units are exactly alike. Check your own unit for basic guide number and color temperture. Use the mired system and correct the color balance of your film and flash. The electronic flash unit is not like the Nikonos BC flash or camera in that it is not waterproof in itself and must, therefore, be placed in a waterproof box or housing of some sort. If you find that you need color correction to balance the color, the filter required in the form of an inexpensive CP (color printing) or gelatin filter can be placed directly over the flash lamp inside the flash housing. These filters are much less expensive than glass filters, and can be cut with a scissors to fit your flash lamp and reflector. Filters are just as effective on the light source as they are on the camera lens and when located on the light source the lens is free of extra glass, so that other optical devices or filters can be used at the same time. Once you find the correct filter for the flash it remains the same and you can always leave it on the lamp. Do correct your guide number as some filters will effect the light output. You can either adjust the guide number or divide the ASA speed of the film by the filter factor to arrive at a new effective ASA film speed. With a BC flash you could also change the shutter speed, but you do not have the same choice of shutter speeds with *X* sync at 1/60th and 1/30th second on the focal plane Nikonos.

Neutral density filters are ideal to put over the flash directly to reduce brillance for close work. This is not so easy to do with flash bulbs as the system is *wet* and filters must be laminated in plastic to survive immersion. Nikonos 4X and 8X screw-in neutral density filters will help where bulbs are too bright for the situation.

TYPICAL ELECTRONIC FLASH GUIDE NUMBERS for KODACHROME II FILM - TABLE 5-9

MFG.	MODEL	K II GUIDE NO	DURATION	COLOR TEMP. K
HONEYWELL	300	40	1/1,200th	-
	65D	80	1/1,500th	-
	500	50	1/1,500th	-
BRAUN	110	37	1/800th	5600
	210	47	1/700th	5600
NIKON	-	56	1/2,000th	6000
ULTRABLITZ	E160	45	1/500th	5600
METEOR	SPGH	variable	1/1,000th	5600
VIVITAR	180	50	1/1,000th	6000
YASHICA	pro-50	33	1/1,000th	5800

It might be worth noting that under some circumstances it is preferable to determine your original guide number by using the double path the light must follow to travel from the flash itself to the film. The light path in this case is approximately twice the estimated distance if the flash is somewhere near the camera - that is the light travels from the flash to the subject, from the subject to the lens. This results in a number about twice as large for your guide number. However, if you decide to place your flash somewhere outside the camera plane and either forward or behind the camera, a more accurate f/number will result by computing with the real light path distance. Most of your original work is salvagable if you have kept good records as it is just a matter of computing the total light path guide number from the known location of the camera lens, the flash and the best exposed subject.

METHODS OF CARRYING FLASH BULBS - FIGURE 5-2

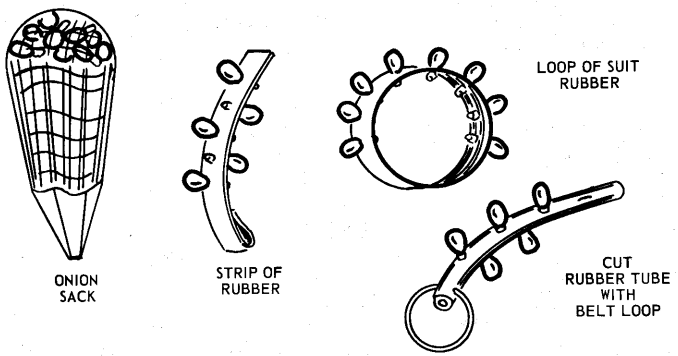

FIGURE 5-2. Flash bulbs are handy sources of light, but they present a real transport problem to the photographer, particularly working through the surf from the beach. Onion sacks or light weight ,shopping bags are are good when diving from a boat or light surf. Strips of rubber or tubing slit for individual bulbs or a loop of suit material all make good all around means of carrying bulbs. Spent bulbs should be put back in the carrier.

Do not become a flash bulb *Litter-bug.* Consider the hazard a broken flash bulb represents to someone walking on the beach. Return those spent bulbs to the boat or the shore in the same device in which you carried them into the water. It is just a little more trouble for you, but when you look out over the clean surface of the sea you will not see a collection of spent flash bulbs (glass beer cans) floating off to be deposited elsewhere, adding to the great litter problem that is spoiling the environment.

Remember unused flash bulbs that have been submerged can be dangerous if fired in the air. If you use them above water, a safety sheld over the reflector is a wise precaution to prevent injury to your subject by a chance explosion.

Underwater or above, some electronic flash units can give you a mild shock if you grasp the synch cord terminals and the unit is fully charged, this is not usually dangerous in itself, but it can cause a scare if you did not expect it.

SECTION 6
ULTRA CLOSE-UP PHOTOGRAPHY WITH THE NIKONOS

Over the last ten years or so underwater photographers have found that by eliminating most of the water in front of the camera lens they could come home with more useable photos. As a rule most of these close in pictures also brought home all the splendor and haunting beauty of the underwater world that was so lacking in more distant underwater photographs.

In seemingly clear water something may be lost, even at moderate subject to lens distance. In dirty turbid water only the most drastic schemes can yield useable photographs.

Close-up or ultra-close-up pictures have become more than a sidelight with underwater photographers and proven above water techniques have been adapted for submerged use with great success.

Close-up pictures are those generally taken closer than the unaided standard lens focusing range. Ultra-close-up pictures are those taken when the focal length of the lens is altered mechanically by insertion of a bellows or extension tube. Where high plus diopter supplemental lenses are used close-up and ultra-close-up can overlap. Macro photography is this close or ultra-close work, whereas microscopic pictures are in a class by themselves and are subjects greatly magnified through a microscope or similar high power optical or electronic instrument.

Your Nikonos can do both close and ultra-close work through the use of Nikonos close-up attachment manufactured by Nikon or an assortment of close-up devices and extension tubes manufactured by others.

NIKONOS CLOSE-UP OUTFIT

The Nikonos close-up outfit is pictured in *Figure 6-1.* The outfit consists of a two element supplemental lens, field frame holder, special BC flash gun clamp, support rod and release lever lock drive wheel, one each framers for the 28, 35 and 80mm Nikonos lenses and a field carrying case made to hold the outfit plus one camera body. The outfit allows parallax free photographs when used with the proper framer and the focus control set at infinity. Note: If the focus control is set at other than infinity the plane of focus is NOT at the framer, but closer to the lens.

If you wish to use the Nikonos close-up outfit at focus control settings other than infinity you could make a special field size wire framer to fit in the regular support bar of the frame holder, size and position the new framer from a device like the Roberts Lens Focuser shown later in this section or calculate the size and position from optical formulas.

The two element plus diopter lens supplement alters the normal lens focal length so that the photographer is able to get closer to the subject. Like other diopter type lenses this unit does NOT require exposure correction as would the same result with extension tubes. Combinations of

diopter lenses and extension tubes used together will require correction for the tubes alone. Diopter lenses by themselves, combined with the camera lens, shorten the basic focal length and makes the effective aperture of the combination larger - thus no need for exposure increase.

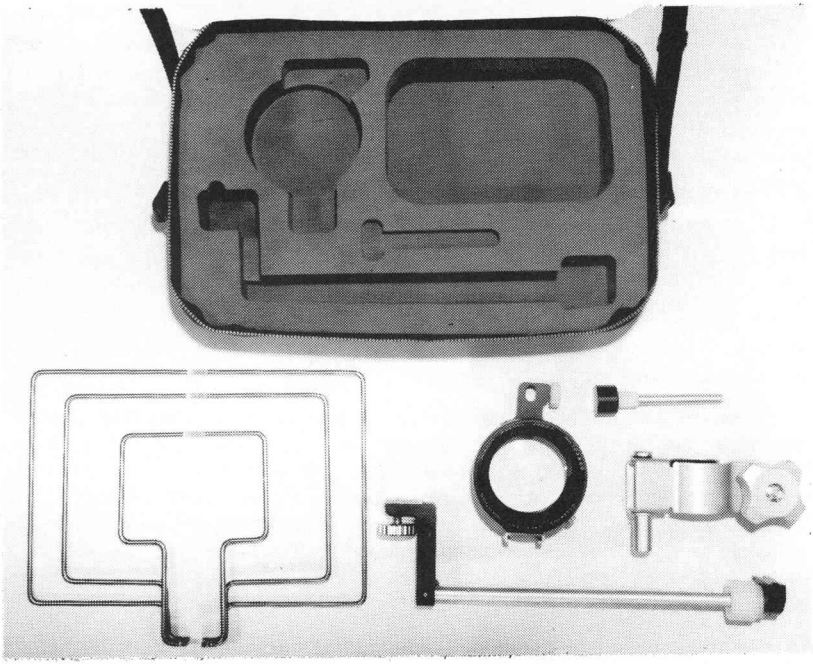

FIGURE 6-1. Nikonos close-up outfit. The two element special supplemental lens is designed to work with the Nikonos 28, 35 and 80mm lenses. It is not designed for use with the Nikonos 15mm, f/2.8, underwater ultra-wide lens which will focus from 12 inches to infinity.

HOW A DIOPTER OR SUPPLEMENTAL LENS WORKS

Your Nikonos 35mm standard lens will focus down to 0.8 meters (2.75 feet), in air, so to get closer to a subject than that will require some optical help beyond the depth of field. This device could be an extension tube if you had one, or a supplemental lens. The supplemental lens that is a standard part of the Nikon system is simple to use and, compared to an extension tube, does not materially alter the exposure to the film.

The supplemental or diopter lens is a meniscus lens very similar to those used in eye glasses. Opticians rate eye glass lenses by a value called dioptic power rather than the more familiar focal length. Concave lenses are rated in minus diopters (for short sighted people) while convex lens are rated in positive diopters (for far sighted people). Commercial supplemental or diopter lenses can be purchased as "telek lens" (Kodak), these are diopter lenses like -1, -2, -3 and -4. Positive diopter lenses may be called "portra lens" (Kodak) or just simply close-up lenses. These are in diopter +1, +2, +3, +4, +5 and so on up to about +10.

To convert from diopters to focal length simply divide the number 100 by the diopter value of the lens. The result is the focal length in the metric unit centimeters. One centimeter is equal to 10 millimeters if you prefer to talk in normal lens focal length language. If you prefer to compute or use the English system of measure divide the focal length value in centimeters by 2.54 (there are 2.54 centimeters in one inch).

Thus a supplemental lens with a diopter power of +2 has a focal length of 100 divided by +2 or 50cm. A diopter lens with a power of +1 has a focal length of 100 divided by +1 or 100cm.

To calculate the effective focal length of your camera lens plus one or more supplemental lenses it is easier to convert to diopter power and return to cm or mm later. To convert your camera lens focal length to diopters again divide the number 100 by your lens focal length in centimeters (a 35mm lens is 3.5cm, 35 divided by 10 as there are 10 millimeters in one centimeter). A standard Nikonos 35mm lens, therefore, has a diopter power of 100 divided by 3.5cm or 28.6 diopters.

To find the combined dioptic power of the camera lens and the supplemental lens, add the diopter powers of the combination, watch the sign of the supplemental lens! To return to focal length for the combination, divide the number 100 by the diopter power of the assembly and the result is the focal length in centimeters(divide by 2.54 converts to inches or by multiplying by 10 converts to millimeters).

If you were to put a +2 diopter supplemental lens over your Nikonos 35mm lens (+28.6 diopters) the resulting new focal length would be +2 plus +28.6 or 30.6 diopters. Divide the number 100 by 30.6 and the result is +3.27cm or +32.7mm. Using the same method a +1 diopter lens on the 35mm camera lens will convert the camera lens focal length to 33.8mm, and a +3 diopter lens over the same camera lens will produce a combined focal length of 31.6mm.

Supplemental lens diopter powers are additive. If you plan to use one or more, convert your camera lens to diopters, add up all the diopter powers of the combination, divide the number 100 by this combined diopter power value and you have the new camera lens and supplemental lens combined focal length in centimeters.

For best results and improved sharpness place multiple supplemental lenses over the camera lens such that the higher diopter value lens is the closest to the camera lens and the weaker further away. Filters used with the combination should be mounted in front of the whole assembly. More than three supplemental lenses or lenses with filters are not recommended as the quality of the image on the film is affected as well as the possibility of image vignetting or edge distortion.

Optical performance of most lenses in combination with supplemental lenses is reduced slightly by adding other glass elements in front. Degradation of the image or field near the edge is most pronounced when the aperture is fully open. Therefore, it is preferred that the f/number with supplemental lenses be f/8 or larger (stopped down) for best results.

Determining the correct focus with supplemental lenses can be a problem if you do not have the diopter lens manufacturers correction tables to convert lens focus values. However, this need not be a serious problem if you use the Roberts lens focuser described in later pages. If you do not have the device you can calculate the infinity position in air and correct the value for underwater use if desired. The main danger with calculations is that a simple math error can easily put you out of focus.

Should you wish to know what supplemental lens is required to focus a subject at the infinity lens setting, it is a matter of converting the lens to subject distance to centimeters, divide the number 100 by this value. The resulting number IS the diopter power of the lens required.

For example if you want to take close-up pictures with the Nikonos 80mm telephoto lens and the subject is 12 inches from the lens, the required supplemental lens would be (in air):

12 inches x 2.54 = 30.5cm

100 divided by 30.5cm = 3.26 diopters. Use +3 lens as this is a standard diopter lens whereas 3.26 is not. With this calculation you know that to use the 80mm lens at 12 inches is going to take about a +3 diopter lens. Now calculate the distance to the subject from the optical center of the lens with the standard +3 diopter lens.

100 divided by +3 = 33.3cm or 13.3 inches. (The 80mm lens must be set at infinity for these calculations to work).

NOTE: The optical center of the lens is not the front edge. Usually this point in a lens is about where the iris is located. In the case of the Nikonos 80mm lens the focus point is not at the iris, but forward of the iris, so a final check with a Lens Focuser may still be in order if you want results the first time.

Any of the other Nikonos lenses could also be used with the +3 diopter supplemental lens and all would focus at 13.3 inches, in air, from the lens with the focus control set at infinity. The major difference in the results would be the size of the image on the film. If the 80mm lens is used in place of the 35mm lens, the image size would be a ratio of the reduction ratios of the two lenses or 2.03X larger than the 35mm lens and 2.5X larger than the 28mm lens at the same distance to the subject in air.

Image size for different subject to lens distances can be calculated by the formula shown below:

$$\frac{OS}{DLS} = \frac{IS}{DLI}$$

Where: OS = Object size in cm.
IS = Image size in cm.
DLS = Distance in cm., lens to subject.
DLI = Distance in cm., lens to image.

For the supplemental lens example on the previous page, a +3 diopter lens over the 80mm camera lens, the image size would be calculated as follows: (Refer to *Figure 6-3*).

New focal length of combination = DLI.

80mm = 8cm = +12.5 diopters (100 ÷ 8).

Supplemental lens is +3.

Diopter power of camera lens and supplemental lens is:

+12.5 (+) +3 = +15.5

100 divided by +15.5 = 6.46cm or 64.6mm = DLI.

Let us assume the original object size was 1 inch or 2.5cm. Distance from the lens to the subject is 13.3 inches or 33.3cm. Distance of the lens to the image is the combined focal length at infinity setting or as above 6.46cm. The last unknown value in the formula is, therefore, the image size "IS". Solving for IS in the formula we have:

$$\frac{OS}{DLS} = \frac{IS}{DLI} \quad \text{or} \quad IS = \frac{OS \times DLI}{DLS}$$

Where: OS = 2.5cm
DLS = 33.3cm
DLI = 6.46cm
IS = ?

Substituting the values for the symbols in the new formula for "IS" we have the following result and solution:

$$IS = \frac{OS \times DLI}{DLS} = \frac{2.5cm \times 6.46cm}{33.3cm} = 0.485cm \text{ *}$$

* The 80mm lens with a +3 diopter lens, with original subject size of 1 inch or 2.5cm.

Suppose the 28mm camera lens were used in place of the 80mm. If our magnification of 2.5X the new image will be 0.485cm divided by 2.5 or 0.19cm. Repeating our calculation using the 28mm lens in place of the 80mm lens we have:

New focal length of combination = DLI.

28mm = 2.8cm = +35.7 diopters (100 ÷ 2.8).

+3 diopter supplemental lens.

+38.7 diopters total

100 divided by +38.7 = 2.58cm = DLI.

OS = 2.5cm (the subject is still 1 inch long).

DLS = 33.3cm (the lens to subject distance is still 13.3 inches).

DLI = 2.58cm (new for the combined 28mm lens and +3 supplemental lens).

$$IS = \frac{OS \times DLI}{DLS} \quad \text{or} \quad \frac{2.5cm \times 2.58cm}{33.3cm} = 0.194cm \text{ image}$$

Mathematical solutions are alright if you like the analytical approach, but you can get the same results for all practical purposes with the Lens Focuser, and you know the results are correct because you can see the end product.

Moving closer to your subject brings your flash unit closer, until a point is reached where the intensity of the flash becomes a problem. This plus the effect on depth of field will be discussed shortly.

Manufacturers other than Nikon are making diopter type close-up lenses and devices which do exactly the same thing as the diopter lens by themselves do, but attach to the lens in a different way than the threaded nose.

It is possible to use a 58mm threaded supplemental lens directly in the nose thread of the Nikonos lens (except the 15mm unit), in place of the special Nikonos hood, which adapts regular Nikon 52mm threaded filters and accessories to the 58mm lens thread. It is necessary, however, to get water between the accessory lens and the camera lens or hydrostatic pressure will cause distortion and possible damage to the accessory lens.

If you use 58mm threaded accessories directly on the Nikonos lens, put the accessory on with the camera lens submerged so that water can enter the space otherwise occupied by air. This could also be done in a pail of water on the boat, but the threads are not watertight so the water could leak out before you got into the water. The Nikonos hood on the other hand lets you thread the filter or 52mm diopter lens into the hood, which in turn is attached to the camera lens with a very leaky thread.

The fact that water eventually enters the space between the camera lens and the supplemental lens does not appear to degrade the picture. However, air bubbles trapped between the units will degrade the results so move the camera back-and-forth several times after you enter the water to be sure no air remains trapped.

There is a very simple way to determine the plane of focus of the various Nikonos lenses when using either supplemental lenses over the standard lens or extension tubes behind the standard lens or any combination of supplemental lenses and extension tubes. This device is the *Roberts Lens Focuser* for the Nikonos, shown in *Figure 6-2.*

The *Roberts Lens Focuser,* was conceived by Fred M. Roberts, to take the time consuming calculations and the trial and error guess work out of close-up photography with the Nikonos. The device takes the place of the camera body (temporarily) for ground glass type focusing of the lens at ANY focus control setting, at ANY f/number of the lens and with ANY diopter and extension tube or combination. The device is used as follows.

USING THE ROBERTS LENS FOCUSER ON THE NIKONOS

1. Remove the Nikonos lens from your camera body and attach whatever combination of extension tubes or diopter lenses or both that you wish to use for your picture.

2. Place the *Lens Focuser* on the back of the lens or tube bayonet mount such that the ground viewing surface is located where the film would be in the camera. Align the viewing screen with the lens control knobs as these are horizontal when the lens is installed in the camera body and this is the proper attitude for the view screen.

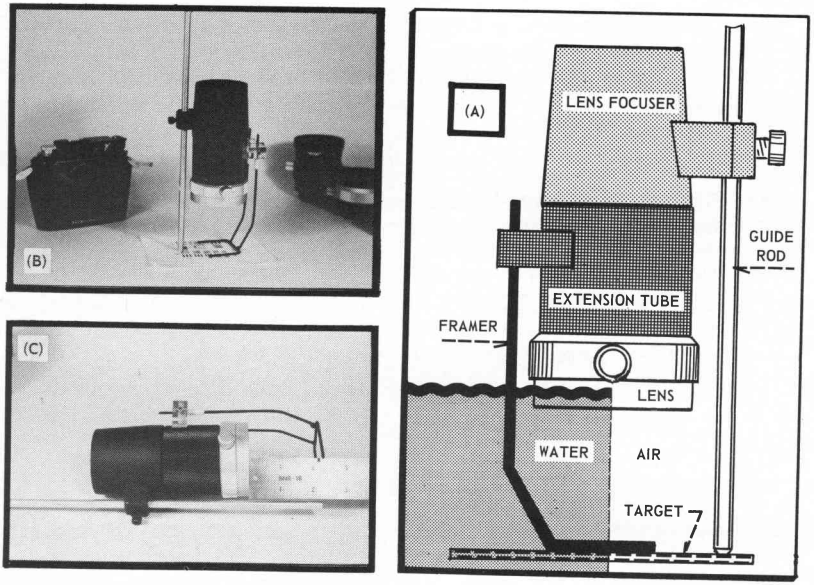

FIGURE 6-2. Roberts Lens Focuser for the Nikonos. (A) Drawing of the Lens Focuser showing position of Focuser and Target for above water and underwater focus measurements. (B) Focuser, Extension Tube and Lens in air measurement attitude. (C) Framer location from Guide Rod setting established during measurement such as shown in (B). After distance to focus point is found re-install the close-up lens assembly to the camera body. The Focuser can also be used to position framers so that they do not appear in the picture and determine depth of field.

3. Hold the lens and the *Focuser* together with your left hand while checking or establishing your plane of focus. The focus control on the lens can be set anywhere you wish, but it is preferred to establish an easily remembered and basic calculating point by using infinity.

4. ABOVE WATER USE: The general method of using the *Focuser* is the same regardless of the end use of the camera, with the exception of where you place your focusing target. The target is anything you wish to use that shows enough detail in the small 35mm format so that you can tell when you are in focus. Above water focusing is best done with a printed copy with large bold letters - like a newspaper headline.

4a. Hold the combination of lens and *Focuser* vertically above your target, refer to *Figure 6-2b,* with the aperture at maximum open, smallest f/number. Later you can close the iris down to see the depth of field if you wish.

4b. Release the guide rod clamp, so that the *Focuser* can be moved freely up and down without binding on the rod.

4c. Move the combination, lens and *Focuser,* up and down until the image of the target on the screen is sharp. It is good practice to go on both sides of focus, then to settle down where maximum sharp-

ness occurs. The rectangular screen is the field of view seen by the particular lens or combination of accessories and lens. This view will aid you in locating your field finder or frames later on if you wish to know where to aim the camera and yet where to locate the field frames so that they are not in the picture. If the frames are now already in your pictures the *Focuser* will help you get them out.

4d. Tighten the guide rod clamp lightly with your finger while holding the combination of the lens and the *Focuser* at sharpest focus.

4e. To find the field focus point, where the subject should be, measure the distance from the front edge of your lens (an easy reference point) to the very end of the guide rod. Lay your scale or ruler parallel to the rod as shown in *Figure 6-2c.*

5. UNDERWATER USE SETTING: Follow the same process as shown above for above water settings, with the following changes. Refer to *Figure 6-2A.*

5a. Select a waterproof target - like a coin.

5b. Select a vessel deep enough to simulate the approximate distance of your framer from the front of the lens. If you do not know where this is located, do the above water focus test first and get your ap-aproximate distance in air, allow about 1.3 times more for underwater.

5c. Fill the vessel with water (it is not necessary to use salt water in the vessel even if you plan to dive in the ocean - fresh water will do very nicely). A bath tub or sink, pail or garbage can or even a back yard pool are acceptable vessels if they are deep enough for your particular lens combination.

5d. Place your combined lens and *Focuser* above the water and lower the combination until the front surface of the LENS port is submerged, DO NOT LET THE REAR OF THE LENS GET WET AS THIS IS NOT DESIGNED TO BE WATERPROOF.

5e. Loosen the guide rod and move the combination, lens & *Focuser* up and down until your target is in sharp focus on the screen. You may need to illuminate your target underwater with a beam of a flash light if the bottom of your vessel is not well lighted, particularly at higher f/numbers.

5f. Tighten the guide rod while holding the combination at sharp focus. Be sure the lens port is in the water and be sure no bubbles of air are trapped on the port or between the port and the close-up device or supplemental lens as you will get a false focus point.

5g. Measure the distance from the front of your lens or diopter accessory lens to the very end of the guide rod just as before. Do this in the air, it is not necessary to keep the front of the lens in the water after you have established the underwater focus distance and retained it with the guide rod.

Place the subject framer at the location established by the end of the guide rod. Since this position was obtained with the lens wide open

the depth of field will extend approximately 2/3rds of the way in front of the framer and 1/3 of the way behind the framer.

If you want to use the lens underwater, but only have framer distance measurements in air, you can come very close to the correct framer location for underwater use by multiplying your air distance, any units of measure, by the factor 1.33. That is, at the same lens focus point the framer will be 1.33X further away from the lens underwater than the same framer would be for use in air at that lens focus. The number 1.33 is the reciprocal of ¾, the factor mentioned earlier to correct underwater focus when the subject distance is measured exactly and not estimated for normal lens use.

DEPTH OF FIELD MEASUREMENTS WITH THE FOCUSER

After you have found the focus point at your largest lens opening (lowest f/number) you may wish to find out where the depth of field zone of focus lies with respect to your framer. Normally it is best to have the near side (the side toward the camera) of your depth of field right at the leading edge of your framer and the depth of field zone projecting away from the framer toward the subject.

To find out where the depth of field lies for the f/number you plan to use (and you may have to find that out later by exposure tests, then fine tune your framer position) stop the lens down to the f/number you know will give you maximum depth of field with the Nikonos -f/22. Since the target now is very difficult to see under normal light you will have to increase the level of illumination to see the image. If you are working around a sink or other grounded water vessel in the home, and are using 110 volt AC on the light source be very careful with that light to avoid a serious accident. A good powerful flash light may be enough to provide the light level to see the target and this is safe to use in the bathroom or sink area without inducing electrical shock hazard.

Place the front port of the lens underwater if your prefocus is for submarine use, *Figure 6-2A,* or as shown in *Figure 6-2B,* if in air. Release the guide rod and move as close to the target as necessary without changing either the lens focus or f/number. When the image is unsharp, move back until it JUST becomes sharp. Lock the guide rod in place and measure the distance with a scale, refer to *Figure 6-2C.*

Repeat the sequence for the "far" focus point. Move the lens away from the target until the image JUST stays sharp. Again lock the guide rod in place and measure the distance. Do not be surprised if the difference between the two guide rod lengths is less than ¼ inch - this narrow depth of field is one of the great problems of close-up photography.

If you have a subject that has depth, and most subjects do, place your framer at the near side of the subject and the depth of field will provide the "far" focus as far as it can at the f/number you are using. Bear in mind that the maximum depth of field occurs with the lens set at it's smallest opening (largest f/number).

After establishing your point of focus remove the *Lens Focuser* and re-install the lens on the camera body. The *Focuser* screen is exactly where the film would be located and, therefore, the film will see exactly what you saw. No more exhaustive "wet" or "dry" field testing for focus is needed for that particular lens combination - change something and you need only repeat the above procedure with the new combination of optics.

The *Lens Focuser* will not tell you what f/number is required for perfect exposure. Your particular light source, film and water conditions or filters will influence this. However, if you are using extension tubes the *Focuser* will allow you to make direct measurements of the image size, thus establishing the magnification, and this will provide the missing component in the "bellows" factor or exposure correction formula.

EXPOSURE CORRECTION FOR LENS EXTENSION TUBES

No *bellows factor* occurs with diopter lenses in front of the camera lens - here you treat the exposure normally, reducing the light source as required due to its proximity to the subject. This correction can be approximately computed as you shall see, but test exposures are the best overall solution for all situations. When you get good results, record this information in your photographic log book for future use.

The *bellow factor* occurs when the lens is taken physically further from the film plane than its focal length. When you use extension tubes (or a bellows in air) the lens is moved away from the film plane thus changing the distance inside the camera that the light must travel. This exposure change is easily calculated if you know the magnification of the subject at the film plane. Magnification is the ratio of the image size to the object size as measured or calculated at the film plane. If a sea shell was one inch long in real life, but appeared only ½ inch long at the focusing screen of the *Focuser*, the magnification would be ½:1 or just 0.5 for use in the formula to follow. If the image is the same size as the original object the magnification is 1:1 or 1; if the image is twice as big as the original object the magnification is 2:1 or 2. The range of magnification is fixed by the length of the extension tube you are using. Refer to the end of this section for other useful optical formulas for close-up work.

The formula to use to compute change of exposure for any extension of the lens is as follows: (Bellows and extension tubes only)

$$\text{Effective Speed ES} = (1 + \text{Magnification})^2$$

If you had a 1:1 ratio, the image is life size on the screen of the *Focuser*, the magnification is 1x and the formula would read:

$$ES = (1 + 1)^2 \text{ or } (2)^2 = 4x$$

The 4x results mean that the speed of the film or the shutter must be reduced 4 times to allow the same amount of light to reach the film plane as before the extension tube was installed. A change in speed of 2x represents one f/number change also, so if it were not possible for some reason to change the shutter speed the f/number can be changed to correct the exposure. When would changing the shutter speed be ineffective? You

cannot alter the effective speed of an electronic flash unit as this is part of the characteristic of the light. Here you still have a choice, however, you can change the type of film you are using - faster film, for example, to maintain the preferred f/number.

With a magnification (reduction) of ½x, the image size is ½ the size of the original subject, the calculations would look like this:

$$ES = (½ + 1)^2 \text{ or } (1½)^2 = 2.25x$$

With a magnification (enlargement) of 2x (2:1), the image is twice life size and the calculation would look like this:

$$ES = (2 + 1)^2 \text{ or } (3)^2 = 9x$$

A speed decrease of 9x represents 3¼ f/stops (each f/stop is equal to twice as much light as the next higher, or in this case 2x2x2+1 left over. If you are using electronic flash you can not change your camera shutter speed to compensate and stay synchronized, therefore, you can change the lens f/number by 3¼ stops or you can use a film that is faster than the one you had planned,to use.

What would you do if you were using an extension tube with an electronic flash unit and you were at least 2 stops under-exposed and your lens was set for maximum depth of field, f/22.

Remember that the maximum depth of field occurs at the smallest lens opening, the highest f/number, so if you open the lens 2 stops to correct the exposure you lose depth of field. Two full stops represents a speed decrease of 4x. Since the electronic flash is used you cannot change the Nikonos shutter speed from 1/60th second and maintain sync. Why not change your choice of film? If you had been using Ektachrome X with a film speed of ASA 64, to increase the sensitivity 4 times you will need a film 4 x 64 or 256 ASA. High speed Ektachrome is only ASA 160. However, Eastman Kodak offers a special developing service called ESP-1 (for an extra fee) that changes High Speed Ektachrome from ASA 160 to ASA 400.

ASA 400 is too much speed for the f/numbers available on the lens. ASA 400 divided by the required speed of ASA 256 represents an excess film speed of 1.56x or about ¾ stop more than you can obtain on the lens already set at f/22. Nikon does not make a 52mm threaded neutral density filter equivalent to 1.5x, but Kodak and other camera accessory manufacturers do make gelatin film squares in ND.2 and this value represents ¾ stop. Refer to *Table A-1,* in the appendix for other values of gelatin film filters. Some of these ND filters are made in glass also, see your local photographic dealer for information on these.

Underwater you cannot use the gelatin film filter directly over your Nikonos lens in this case as the filter material is not waterproof. However, our example says you are using an electronic flash unit and this is not usually waterproof either, but is in a waterproof housing. By placing the ND.2 neutral density filter over the face of the strobe you will reduce it's light output by ¾ stop, which is exactly what you need.

It would also be possible to laminate a larger square of gelatin ND filter material in plastic to fit a waterproof strobe unit without built-in power reduction capability for close work.

Many other manufacturers than Kodak make color film and one of these films might meet your needs better. for example Anscochrome 200, ASA 200. If you used this film for the situation in the preceding example where ASA 256 is required then ASA 256 less ASA 200 leaves you only ASA 56 short, or in speed variation, 56 divided by 256 is .22 (about ¼x), which would be within the exposure latitude of the film if you made no correction at all. If you did wish to get the exact exposure and a field test showed you that you needed one, either an f/number adjustment would be in order or a change to the neutral density filter on the electronic flash face.

If you had the same situation, but were using flash bulbs not an electronic flash, you could use a laminated neutral density gelatin film filter over your flash reflector or you could use the Nikonos 4X 52mm screw-in filter and adjust the film speed or shutter speed until you had a proper match while still maintaining a small aperture for best depth of field. When using FP flash bulbs your Nikonos is synchronized at all the shutter speeds shown in *Table 5-1*.

Photography is not always as simple as "aim and shoot". When you are working in a complex situation like close-up, you have a number of ways to get results & sometimes you must try more than one to achieve the results you desire. This is commonly called EXPERIENCE.

Before leaving this discussion on filters for the Nikonos it should be mentioned that Vivitar, another lens manufacturer, makes diopter and ND filters in 58mm threaded mounts. These will fit the nose thread of the Nikonos lens without the hood. The Vivitar 2X ND filter (they have a 2X and a 4X ND filter) can be used directly in the lens nose thread if the filter is applied with the lens submerged so that water gets between the filter and the front lens port. These filters are not made for use in salt water, but will stand-up reasonably well if you wash them after each use with fresh water and dry them carefully.

EXPOSURE CLOSE-UP WITH FLASH

At best a calculated exposure correction for your light source - bulbs or strobe - is an educated guess that requires an actual exposure test to confirm. However, a calculated exposure is a good starting point as one could waste considerable film even getting to this point without some form of guide lines.

To compute approximate close-up exposure change from known distance value, first determine a satisfactory f/number at a given distance. Use your corrected underwater guide number for below water or the bulb or strobe guide number directly above water. Your strobe exposure computer probably goes to 3 feet and you should have no problem finding an f/stop at or near this distance.

For ease of calculation let us assume an even distance number like 4 feet to start with. When you advance toward your subject with the flash unit and camera ¼ of the distance, i.e. 1 foot, stop down one full stop. When you move ¼ of the way again (¼ of 3 feet, the distance left after the first move) you advance 0.75 feet or 9 inches, stop down one more full stop on the lens. Reduce the aperture or available light level one full stop for each ¼ reduction in the *remaining* distance.

If by the time you arrive at the actual distance of your subject from the light and you have an estimated f/number much larger than the f/22 possible on your Nikonos lens, you will need (1) a slower film or (2) less light. Less light is possible by employing faster shutter speeds, for FP sync bulbs, not strobe, smaller watt-second output strobe units or neutral density filters on the camera lens or the light source.

You may say at this point in the discussion, "Wouldn't I get the same thing by test exposures?". Yes, if you wish to spend the time and pay the price of film and processing you could get to the right exposure by testing alone. If you get lost in the theory or math required, test exposures are certainly a way to an end. On the other hand, if you experiment and learn the theory, no situation will resist your effort and you will become a better photographer.

Once in awhile you may find yourself without enough time to run test exposures. If you find yourself in this situation, diving a "once in a lifetime" spot, you take the chance of no results, poor results, fair results or good results. Not very good odds if you are using color film with its very narrow latitude of exposure.

If you do calculate or predetermine approximate exposure values, do it in a photographic log book so that in the future you have a reference point for other such experiments.

The use of close-up supplementary diopter lens (before the lens) and extension tubes (behind the lens), or combination of lens and tubes will open a whole new world of photography. You will find yourself looking at your environment through a new eye, things that were small and unnoticed now become attractive and attainable with the camera lens. The hidden world of nature is no longer quite as mysterious as before.

What you select to photograph,or your skill at composition, is beyond the scope of this booklet. However, subjects related to other aspects of underwater and topside photography will be covered in companion volumes dealing with specific subjects.

Your Nikonos is a fine precision machine capable of superb results. If you now better understand the means of utilizing your camera system, and have increased the range and utility of your camera in your hands, then the purpose of this book has been realized.

USEFUL OPTICAL FORMULAS

For those who wish to delve deeper into the mathematical aspect of close-up photography the following formulas should be at least a starting point. Refer to *Figure 6-3*, for a diagram of important Nikonos lens locations for the formula values.

It is not within the scope of this book to go into more detail on close-up photography and its related problems. However, a companion book of this series will be devoted to this subject.

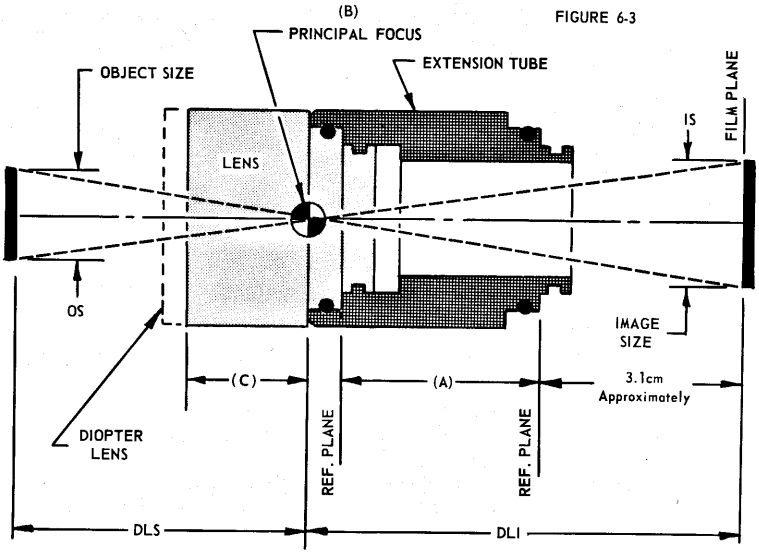

FIGURE 6-3

IS = Image size in cm.
OS = Object or subject size in cm.
DLS= Distance from lens to subject in cm.
DLI = Distance from lens principle focus to image in cm.
M = Magnification or reduction ratio.
F = Focal length of the lens in cm.
R = Reproduction ratio.
BF = Bellows factor.
ASA = American Standard Association (film speed rating system).

(A) Dimensions for *Anchor Shack* brand tubes are: #1 2.6cm; #2 5.19cm and numbers 1+2 7.79cm Approximately.

(B) Principle Focus in a lens is approximately located at the iris diaphragm.

(C) Measurements from the principle focus to the edge of the lens for the Nikonos 28mm lens is about 3.3cm; for the 35mm lens about 2.3cm and for the 80mm lens about 1.29cm.

(D) Insufficient data available, at this publication, on the 15mm f/2.8 ultra-wide angle Nikonos lens to evaluate results of these calculations, however, a bellows factor of 38.4 (1+2) would mean High Speed Ektachrome film, ASA 160, would have an effective film speed of 160 ÷ 38.4 or 41.6 ASA effective. Still fast enough for some uses.

FORMULAS

$$\textbf{IMAGE SIZE} = \frac{(OS)(DLI)}{DLS} = IS$$

$$\textbf{OBJECT DISTANCE} = \frac{(DLI)(F)}{DLI - F} = DLS$$

$$\textbf{REPRODUCTION RATIO} = \frac{OS}{IS} \text{ or } \frac{DLS}{DLI} = R$$

$$\textbf{MAGNIFICATION or REDUCTION RATIO} = \frac{IS}{OS} = \frac{1}{R} = M$$

$$\textbf{BELLOWS FACTOR} = (M+1)^2 = BF$$ *(Used with bellows or tubes)*

BELLOWS FACTOR for ANCHOR SHACK extension tubes, focus set at infinity. Values for other tubes can be calculated from formulas above.

NIKONOS LENS	BELLOWS FACTOR			NOTE
	#1	#2	#1+2	
15mm	7.48X	19.9X	38.4X	(D)
28mm	3.12X	6.84X	11.2X	-
35mm	2.66X	5.64X	9.74X	-
80mm	1 56X	2 55X	3 56X	-

$$\textbf{EFFECTIVE FILM SPEED} = \frac{ASA}{BF} = \text{ASA effective}$$

(NOTE: The effective film speed is the speed for your meter setting or the value to use when calculating a flash guide number).

Tables in Section 6 include the 15mm lens in filter factor calculations for extension tubes, but it is unlikely that this lens will work without distortion or image vignetting due to the proximity of the rear element to the film plane.

APPENDIX SECTION
NIKONOS SPECIFICATIONS

PICTURE SIZE:	24x36mm.
FILM SIZE:	35mm width, Cassette type with 20 or 36 exp.
LENSES:	15mm f/2.8; Aperture range - f/2.8, 4, 5.6, 8, 11, 16 and 22 with click stops; Focus range - 12 inches to infinity. Supplied with shoe mounted optical viewfinder.
	28mm f/3.5; 5 groups, 6 elements (front concave lens included); Picture angle 59 degrees underwater; Aperture range - f/3.5, 4, 5.6, 8, 11, 16 and 22 with click stops; Focus range - 2 feet (0.6m) to infinity. Attachment size (nose) 58mm, pitch 0.75 millimeters.
	35mm f/2.5; 4 groups, 6 elements (front glass port excluded); Picture angle 46 degrees underwater; Aperture range-f/2.5, 4, 5.6, 8, 11, 16 and 22 with click stops; Focus range - 2.75 feet (0.8m) to infinity; Attachment size (nose) 58mm, pitch 0.75mm.
	80mm f/4; 4 groups, 4 elements (front glass port excluded); Picture angle 30 degrees, 20minutes in air, 22 degrees underwater; Aperture range 4, 5.6, 8, 11, 16 and 22 with click stops; Focus range - 3.5 feet (1m) to infinity; Attachment size (nose) 58mm, pitch 0.75mm; weight in air 275gr.
SHUTTER:	Focal plane, vertical duralumin curtains, self-capping type.
SHUTTER SPEEDS:	B,1/30, 1/60, 1/125, 1/250, 1/500 second. Equi-distant graduated scale with click stops.
VIEWFINDERS:	Albada type; 35mm lens - Bright frame coverage and parallax compensation corner markings for 2.75 feet (0.8m).
	80mm lens - Accessory shoe mounted bright frame coverage, parallax compensation control, distance calibrations to match lens values.
FILM ADVANCE:	Actuated by one stroke, 73 degree, lever on camera body.

NIKONOS SPECIFICATIONS

SHUTTER COCKING:	Automatically operated by returning spring motion of film advance-release lever.
SHUTTER RELEASE:	Actuated by 8 degree motion of the film advance-release lever, moved towards body.
FILM REWIND:	Lift-up crank with shutter dial set at "R".
FILM PRESSURE PLATE:	Hinged to facilitate film loading.
FLASH SYNCHRONISM.	Waterproof socket with FP and X contacts.
EXPOSURE COUNTER:	36 continuous, 2 per mark, automatic return to zero with removal of the inner body.
CAMERA BODY:	Impregnated die-cast aluminum, "O" ring seal.
ACCESSORY SHOE:	Spring lock type, standard configuration.
TRIPOD SOCKET:	Located in sync port plug, thread ¼-20 UNC.
DIMENSIONS (no lens):	3.9 inches high x 5.1 in. wide x 1.9 in. deep.
WEIGHT (no lens): Air	20 ounces (540 grams).
CLOSE-UP OUTFIT:	Lens - 2 groups, 2 elements; Subject distance 235mm from vertex of lens, camera lens set at infinity. Magnification - 28mm lens 1/6x underwater. 35mm lens 1/4.5x underwater. 1/6.5x in air. 80mm lens 1/2.2x underwater. 1/3x in air. Weight - 20 ounces (540 grams) with 28mm subject framer. Accessories - Three subject framers, stainless steel, full frame type for 28, 35 & 80mm lenses. Close-up flash holder. Foam filled compartment case for flash close-up holder, framer support attachement and lens support and safety cam remote drive wheel.
SPORTFINDERS:	Shoe mounted, open frame type, viewing distance 85mm, underwater frame coverage 10 ft. or 3m. 35-80mm combination, plastic, zero parallax distance 2m underwater. 28mm, rubber, zero parallax focus distance unspecified.
LENS HOOD:	58mm lens thread, pitch 0.75mm, internal thread 52mm for Nikonos (Nikon) threaded filters.

NIKONOS SPECIFICATIONS

PRESSURE RING: Accessory ring, supplied with 28mm lens, screw into the 58mm nose thread to apply pressure to the port to insure watertightness of lens when in air and not subject to hydrostatic pressure.

CAMERA CASE: Accessory, soft leather, camera neck-strap used.

SUPPLEMENTARY GRIP: White and black, rubber, used to facilitate operation of lens controls when wearing gloves.

FLASH ADAPTOR: PC sync cord adaptor fits in body flash port. Dials synchronization - Red FP, Black X, for use in air only, not underwater.

BC FLASH UNIT: Adjustable angle, extension length & detachable from the camera mount while submerged. Satin Chrome dish reflector with bayonet base flash bulb socket, lever bulb release.

AG BULB ADAPTOR: Used with BC flash unit to reduce size of bayonet to accept AG flashbulbs in air or underwater.

LIGHTMETER: Molded plastic housing, "O" ring sealed, designed for the Sekonic Auto-Lumi meter model L-86 exclusively, meter range f/1 to f/32; Shutter speeds 8 seconds to 1/2000th second; Film speeds ASA 6 to 12,000; EVS film speed scale 2 to 19; Din film speed scale 3 to 42. Photo-electric cell, no battery is required. Single control, "O" ring sealed and adjustable while submerged.

COMMON NEUTRAL DENSITY FILTERS. TABLE A-1.

DENSITY	PERCENT TRANSMISSION	FILTER FACTOR (X)	INCREASE IN STOP
0.10	80.0	1.2	½
0.20	65.0	1.5	¾
0.30 (2x)	50.0	2.0	1
0.40	40.0	2.5	1¼
0.50	32.0	3.1	1¾
0 60 (4x)	25.0	4.0	2
0.70	20.0	5.0	2¼
0.80	16.0	6.2	2¾
0.90 (8x)	13.0	7.7	3
1.00	10.0	10.0	3¼

NEUTRAL DENSITY FILTER SELECTOR CHART. TABLE A-2

f/STOP FOR CORRECT EXPOSURE	SMALLEST f/STOP OF LENS	
	f/16	f/22
	ND FILTER TO USE	
f/22	ND .3	none
f/32	ND .6	ND .3
f/45	ND .9	ND .6
f/64	ND 1.2	ND .9
f/90	ND 1.5	ND 1.2
f/128	ND 1.8	ND 1.5
f/180	ND 2.1	ND 1.8
f/256	ND 2.4	ND 2.1

SUGGESTED READING

BOOKS

E.R. Cross, *UNDERWATER PHOTOGRAPHY and TELEVISION.* New York, Exposition Press, 1954.

O.R. Croy, *HOW TO USE YOUR CAMERA CLOSE-UP.* New York, The Focal Press, Distributed in the U.S. by Amphoto, 1961.

Frey and Tzimoulis *CAMERA BELOW.* New York, Association Press, 1968.

T.H. Miller and W. Brummitt, *THIS IS PHOTOGRAPHY.* New York, Doubleday and Company, Incorporated, 1963.

Fred M. Roberts, *BASIC SCUBA.* New York and Ohio, D. Van Nostrand, Litton Educational Publishing Company, 1963.

Schenck and Kendall, *UNDERWATER PHOTOGRAPHY.* Maryland, Cornell Maritime Press, 1957.

BOOKLETS

Jerry Greenberg, *UNDERWATER PHOTOGRAPHY SIMPLIFIED*, Florida Seahawk Press, Distributed by La Grange, Inc. Hollywood, Calif. and Skokie, Illinois, 1956.

Dimitri Rebikoff & Paul Cherney, *A GUIDE TO UNDERWATER PHOTOGRAPHY.* New York, Greenberg Modern Camera Guide Series, 1955.

Kodak Data Book Series:
Kodak Lenses, Shutters and Portra Lenses, Publication B-3.
Kodak Filters and Pola-Screens for B&W and color films, Publ. B-1.
Kodak Wratten Filters for Scientific & Technical Use, Publ. B-3. This publication may replace the booklet listed first on the list. Both carry the publication number B-3, but the former is a 1955 edition.

Kodak Technical Publications Series:
Close-Up Photography, Publication N-12A.

MAGAZINES

SKIN DIVER MAGAZINE, 7833 Sunset Blvd., Los Angeles, Cal 90069.

DIVE MAGAZINE, Gaff Productions, Inc., 4138 Atlantic, Long Beach, California 90807.

UNDERWATER NEWS, 771 W. 19th St., Costa Mesa, California 92627.

SKINDIVING IN AUSTRALIA, Australian Sports Publications, 54 Schutt Street, Newport, Victoria, Australia 3015.

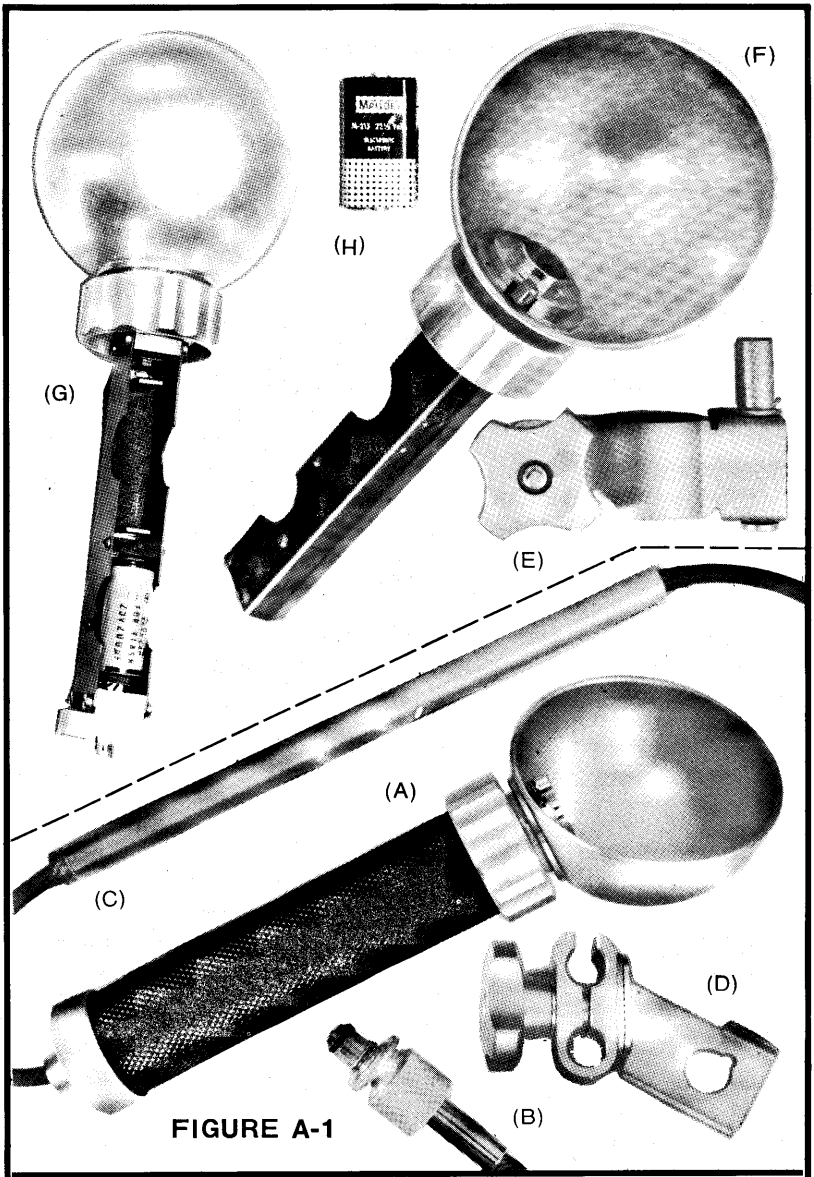

FIGURE A-1. NIKONOS BC FLASH UNIT. Refer to Section 5 for details of operation. (A) Flash gun (Battery-Capacitor unit) & Reflector; (B) Special flash terminal connector; (C) Extension arm; (D) Adjusttable Camera Body mount; (E) Special flash gun holder from Nikonos Close-Up Outfit; (F) Bulb socket and spent bulb release; (G) View inside Battery-Capacitor case; (H) 22.5 volt Battery (MEDA #215) or Mallory M-125, Burgess U15 or Eveready 412.

NIKONOS UNDERWATER 15mm NIKKOR f/2.8 LENS

FIGURE A-2

FIGURE A-2. THE NIKONOS UNDERWATER 15mm NIKKOR f/2.8 LENS. This ultra-wide angle lens is corrected for use underwater only. Its 94° picture angle makes it ideal for use in murky water, where the cameraman must get close to the subject. The 15mm Nikkor lens comes with its own wideangle viewfinder. The lens is a true ultra-wide without the fisheye image look.

LENS SPECIFICATIONS: Focal length 15mm; Maximum aperture f/2.8; Lens construction, 9 elements in 5 groups; Picture angle is 94° underwater; Distance scale, infinity to 0.3 m (12 inches), graduated in both feet & meters; Aperture scale f/2.8 to f/22; Mount, Nikonos special; Attachment size 84mm, pitch 0.75; Dimensions are 92mm (3-5/8 in.) dia. x 74mm (2-29/32 in.) length; Weight is 300 grams (10.6 oz.) in air.

FINDER SPECIFICATIONS: Magnification is 0.24x; Field ratio is more than 90%; Lens construction, 3 elements in 3 groups. Mounts to camera accessory shoe. Designed for underwater use.

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