RETINAL PHOTOGRAPHY PROTOCOL

1 INTRODUCTION

The Cardiovascular Health Study (CHS) Study is an epidemiological research study of the major factors related to the incidence and progression of cardiovascular disease in a cohort of participants with the mean age of 80 years. The study has two main objectives: (1) to investigate factors associated with both atherosclerosis and incidence of clinical cardiovascular disease, and (2) to measure coronary heart disease (CHD) occurrence and trends and relate them to community levels of risk factors, medical care, and atherosclerosis.

The study will examine 4,000 subjects including men, women, blacks and whites during a one year examination period beginning June 1, 1997. Examinations will be conducted in four US communities located in Forsyth County, North Carolina, Pittsburgh, Pennsylvania, Sacramento, California, and Washington County, Maryland.

Fundus photographs will be used to evaluate abnormalities in the retinal vasculature (presumed to be related to hypertension and/or arteriolar sclerosis) that may be prognostic for various cardiovascular outcomes. Generalized and focal narrowing of arterioles and changes in arterio-venous (A/V) crossings will be evaluated. Other significant retinal conditions will be noted, such as retinopathy or vascular occlusions in people with and without diabetes.

One 45 degree non-mydriatic (i.e., not requiring pharmacologic dilation of the pupil) retinal photograph will be taken of one eye of each of the 4,000 subjects. The photographs will be sent to the CHS Retinal Reading Center for assessment of retinal status.

2 EQIPMENT AND SUPPLIES

2.1 **The Canon CR-45UAF Camera**

A Canon non-mydriatic, auto-focus fundus camera with 35mm camera back will be used for this project. (A Polaroid camera attachment will be used during the training session to provide instant photo quality feedback.) The camera is mounted on a motorized instrument table to allow optimum alignment. Both photographer and subjects have pneumatically adjustable stools, the latter with a back rest.

The Retinal Reading Center proposes <u>one modification to the camera, the attachment of an aligning mask to the viewing monitor</u>. The transparent mask has two circles, labeled R and L, within which the photographer centers the optic disc of the right or left eye, respectively. The mask is taped to the monitor screen. It is easiest to attach the mask with the camera on and the external viewing function engaged. With the external viewing function engaged, the central viewing circles (used to align the pupil during photography) are visible and can be used to center the mask. The mask should be positioned with the right and left (R and L) circles equidistant from the viewing circles, and with centers of the mask circles

about 2 millimeters higher than the center of the concentric viewing circles. It is important to position the mask in relation to the viewing circles and NOT in relation to the edges of the monitor.

Additional transparent grids are available from Michael Neider at the CHS Retinal Reading Center, 610 N. Walnut Street, Room 450, Madison, WI 53705-2397.

2.2 **Supplies**

Each site will need a small light table and magnifier suitable for viewing and sorting the retinal slides. Additionally, a list of supplies that need to be reordered on a repeat basis follows:

(a) Slide film Kodak Professional Ektachrome 100 EPN, 36 exposure, is required. The Kodak catalog number is 142-9539.
(b) Photographic lens cleaning cotton: long-grain Red Cross sterile batting
(c) Lens cleaning fluid (100% alcohol)
(d) Kleenex tissues
(e) Spare view lamp, split lamp and Canon camera fuses
(f) Bardes, side-loading, clear plastic slide mounting pages, #62022C, Bardes Products, Inc., 5245 W Clinton Ave, Milwaukee, WI 53223
(g) Film roll processing labels (1" X 2")
(h) Compressed air for lens cleaning - 4oz Falcon with nozzle

2.2.1 Inventory

An inventory of supplies for each of 4 study centers, assuming an average of 1,100 subjects per center, follows:

(a)	Professional Ektachrome 100 film	31 rolls, 36 exp.(minimum)
(b)	Lens cotton	One 4 oz. box
(c)	Lens cleaning alcohol	1 8oz. bottle
(d)	Facial tissues	6 boxes (200 tissues/box)
(e)	Spare lamps	1 view and split
(f)	Film roll labels	31 (minimum)
(g)	Bardes plastic slide pages	110 20-pocket pages

2.3 **Equipment Set-up**

2.3.1 Daily Set-up Procedure

The camera dust cover and lens cap should be removed at the beginning of the day and the lens inspected and cleaned (see section 2.4.1) as necessary. Dust is the greatest enemy, producing the majority of artifacts on the photographs. **When the camera is not in use, the lens cap should be in place and the special dust cover must remain on the camera.** The 35mm camera back should be checked for sufficient battery power (see page 26 of the Operations Manual) and the film counter should be checked to be certain that the camera is loaded with film before beginning photography.

2.4 **Care and Maintenance of Equipment**

2.4.1 Lens and Camera Body Care

Before each photograph, the camera lens must be inspected and, if dirty, cleaned with the brush and air bulb to remove debris. Should more extensive cleaning of the lens be required, the lens can be fogged with your breath or moistened with absolute alcohol (100%) and then cotton should be used in a circular polishing motion until no dirt or oily film is visible on the lens when it is viewed from the front with the alignment lens removed and the view lamp on and turned up to its maximum intensity (see page 42 in the Operation Manual). The body of the camera should be kept clean and free of dirt with a soft cloth and water or a common spray cleaner like 409. The headrest may be cleaned with alcohol. The inside of the 35mm camera back is inspected for dirt and film fragments each time the film is changed. The air bulb or a puff of air is used to clean inside the camera back. The infra-red mirror relay lens assembly is cleaned as necessary to remove dirt or dust when seen on the display monitor. While these specks do not affect final photo quality, they are distracting and should be removed.

2.4.2 Instrument Table and Stools

The instrument table and stools can be kept clean by wiping with a common spray cleaner and a soft cloth. Occasionally the castors on the table and stools may squeak requiring a drop of light oil. The electric motor on the table requires no lubrication. The motor is protected by fuses that may need replacing should excessive current blow them out.

2.4.3 Flash, View and Split Lamp Concerns

The Canon cameras have been refurbished by Canon USA and will be equipped with all new lamps at the beginning of the study. It is anticipated that the flash, view and split lamps might fail before the end of the study. The view and split lamp should last approximately one to two years and the flash lamp has a life of at least 5,000 flashes, enough to complete the study. Since the view and split lamps are relatively inexpensive bulbs, one spare for each should be ordered from Canon and kept at the field center. The flash lamp is expensive, and can be ordered from Canon when needed for overnight delivery.

As the flash lamp ages, the light output can diminish, producing progressively darker photographs. This can temporarily be over-ridden by an adjustment of the transformer output, though ultimately the lamp should be replaced. The decision to replace the lamp, due to dark photos, will be made with the Photography Consultant following routine review of processed photographs. All lamps require careful handling during installation (a burnt out lamp may be hot, and the new lamp must be properly cleaned and aligned), thus replacement should be made only by Canon staff who have been trained to do this.

2.4.4 Film Concerns

The most consistent exposure will be obtained using a professional grade slide film such as Professional Ektachrome 100 (EPN). Professional grade films must be stored at a temperature of 55° F or lower. A conventional refrigerator is the perfect storage container for the Professional Ektachrome. Please remove the film from refrigeration at least 1 hour

(but no more than 24 hours) to allow it to warm to rom temperature before use. This warming is necessary to prevent condensation inside the camera or film tearing which can occur when the film is cold.

You may also freeze this film if refrigerator space is at a premium. In this case, please be sure to remove any rolls at least 3 hours before use to allow ample time for the film to reach room temperature. During this time it is best to leave the frozen film in its plastic storage container to prevent condensation

.

It is not desirable to refrigerate the film after exposure. It is important that film not be stored near x-ray equipment since x-rays can severely damage the film. Film should be developed promptly after the last exposure is taken.

2.4.5 Camera Malfunctions or Errors

Since the camera requires virtually no other maintenance, any malfunction will need to be investigated first by the examiners at each center and, when necessary, via telephone with the Retinal Reading Center Photography Consultant. Trouble-shooting tests can be performed in consultation with the consultant to diagnose any malfunction. Some camera malfunctions or photographer errors are not evident during photography and will only be discovered after examination of the processed films. This includes camera flash synchronization, transformer power settings, problems with a dirty objective lens or film loading problems. For this reason, prompt processing of the film is important. A telephone link should be available between the photographers and the Photography Consultant at all times should a malfunction be discovered during the photography or following processing, or should the photographers have a problem or question needing immediate attention. The Photography Consultant, Michael Neider, can be reached at 608-263-9858 at the University of Wisconsin-Madison, Wisconsin.

Service information can also be obtained directly from Canon USA in Itasca, Illinois or Lake Success, New York. Our contacts there are Tom Penkala and Mark Scheckle, Canon USA, 100 Park Blvd., Itasca, IL 60143-2693, telephone number: 630-250-6230 or Ron Kaiser, Canon USA, 1 Canon Plaza, Lake Success, NY 11042-1113, telephone number: 516-328-4645.

3 PRE-EXAMINATION INTERVIEW

Prior to taking the retinal photograph, a number of questions regarding ocular health care, procedures and problems with the eyes, and vision will be asked. Included in this interview are the "activities of daily vision". This questionnaire may be administered during the time that the participant's eyes are adjusting to the dark if the technician is able to read the form using only the red light. The questions should be asked in the format similarly to other CHS interview forms. All questions are responses are listed below.

- Question 1 - When was the last time you say a doctor, optometrist, or eye specialist concerning your vision?

  - Record responses from the following options:

    0 - Never
    1 - Less than 1 year
    2 - At least 1 year but less than 2 years
    3 - At least 2 years but less than 3 years
    4 - 3-10 years
    5 - Greater than 10 years
    9 - Unknown

- Question 2 - Has a doctor ever told you that you had diabetes?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no.

  - If yes, ask participant the number of years that he/she as had diabetes, and ask if he/she has ever had any problems with his/her eyes as a result of diabetes. Record responses in space provided on form.

  - If participant notes that he/she has had any problems with his/her eyes due to diabetes, record the responses to the following questions:

    - Which eye or eyes were affected?
    - Have you ever had laser treatment on your eyes for diabetes?
    - On which eye or eyes?

- Question 3 - Has a doctor ever told you that you have eye problems as a result of glaucoma, or increased pressure inside one or both of your eyes?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Unknown' if the participant is unsure or does not remember. If no or unknown, skip to Question 4.

  - If yes, ask participant which eye or eyers were affected and record response in space provided on form.

- Question 4 - Has a doctor ever told you that you have eye problems as a result of age-related macular degeneration?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Unknown' if the participant is unsure or does not remember. If no or unknown, skip to Question 5.

  - If yes, record the responses to the following questions:

- Which eye or eyes were affected?
- Have you ever had laser treatment on your eyes for macular degeneration?
- On which eye or eyes?

■ Question 5 - Has a doctor ever told you that you have eye problems as a result of cataracts, or cloudiness of the lens, in one or both of your eyes?

- Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Unknown' if the participant is unsure or does not remember. If no or unknown, skip to Question 6.

- If yes, record the responses to the following questions:
  - Which eye or eyes were affected?
  - Have you ever had eye surgery on your eyes because of cataracts?
  - On which eye or eyes?

■ Question 6 - Has a doctor ever told you that you have eye problems as a result of blockage of an artery or vein in one or both of your eyes?

- Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Unknown' if the participant is unsure or does not remember. If no or unknown, skip to Question 7.

- If yes, record the responses to the following questions:

  - Which eye or eyes were affected?
  - Have you ever had laser treatments on your eyes for this blockage?
  - On which eye or eyes?

Activities of Daily Vision Begin Here:

■ Question 7 - Do you have any difficulty, even with glasses, reading small print, such as labels on medicine bottles, a telephone book, or food labels?

- Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant cannot read and does not ever attempt to do this. If no or not applicable, skip to Question 8.

- If yes, ask participant how much difficulty he/she has and

record one of the following responses: '1 - A little', ' 2 - A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 8 - Do you have any difficulty, even with glasses, reading a newspaper or book?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant never does this activity. If no or not applicable, skip to Question 9.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 - A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 9 - Do you have any difficulty, even with glasses, reading a Large-print book, large-print newspaper or numbers on a telephone?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant does this activity. If no or not applicable, skip to Question 10.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 - A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 10 - Do you have any difficulty, even with glasses, recognizing people when they are close to you?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant does this activity. If no or not applicable, skip to Question 11.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 - A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 11 - Do you have any difficulty, even with glasses, seeing steps, stairs or curbs?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant does this activity. If no or not applicable, skip to Question 12.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 -

A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 12 - Do you have any difficulty, even with glasses, reading traffic signs, street signs or store signs?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant does this activity. If no or not applicable, skip to Question 13.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 - A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 13 - Do you have any difficulty, even with glasses, doing fine handiwork like sewing, knitting, crochet or carpentry?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant does this activity. If no or not applicable, skip to Question 14.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 - A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 14 - Do you have any difficulty, even with glasses, writing checks or filling out forms?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant does this activity. If no or not applicable, skip to Question 15.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 - A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 15 - Do you have any difficulty, even with glasses, playing games such as bingo, dominos, card games or mahjong?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant does this activity. If no or not applicable, skip to Question 16.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 -

A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 16 - Do you have any difficulty, even with glasses, taking part in sports like bowling, handball, tennis or golf?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant does this activity. If no or not applicable, skip to Question 17.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 - A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 17 - Do you have any difficulty, even with glasses, cooking?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant does this activity. If no or not applicable, skip to Question 18.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 - A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 18 - Do you have any difficulty, even with glasses, watching television?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no or '9 - Not Applicable' if the question is not pertinent, such as the participant does this activity. If no or not applicable, skip to Question 19.

  - If yes, ask participant how much difficulty he/she has and record one of the following responses: '1 - A little', ' 2 - A moderate amount', '3 - A great deal', or '4 - Unable to do the activity'.

- Question 19 - Do you currently drive a car?

  - Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no. If participant does not drive a car, skip to Question 20.

  - If yes, ask participant how much difficulty he/she has driving during the day because of his/her vision; record one of the following responses: '1 - No difficulty', ' 2 - A little difficulty', '3 - Moderate difficulty', or '4 - A

great deal of difficulty'.

- If yes, ask participant how much difficulty he/she has driving at night because of his/her vision; record one of the following responses: '1 - No difficulty', ' 2 - A little difficulty', '3 - Moderate difficulty', or '4 - A great deal of difficulty'.

- All participants who answered this question skip to Question 21.

■ Question 20 - Have you ever driven a car?

- Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no. If participant has never driven a car, skip to Question 21.

- If the participant has driven previously (but not currently), as when he/she stopped driving. Record '1 - Less than 6 months ago' , '2 - 6-12 months ago', or '3 - More than 12 months ago'.
- Ask the participant why he/she stopped driving. Record if the reasons was due to '1 -Vision', '2- Illness', or '3 - Other reason'.

■ Question 21 - Are you completely blind in one or both eyes?

- Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no. If response is no, skip to Question 22.

- If yes, ask which eye (or both) is completely blind.

■ Question 22 - have you ever had an eye removed?

- Record '1 - Yes' if participant responds yes, record '0 - No' if the participant responds no. If response is no, continue with photograph procedure.

- If yes, ask which eye (or both) was removed.

The interview portion of the retinal photography procedure is now completed. Continue with the examination/photograph protocol as described below.

4 EXAMINATION PROTOCOL

All subjects will have one 45-degree photograph taken of one eye. The eye to be photographed will be selected based on the subject's 7-digit ID number. When the ID number is even, the right eye will be photographed,

and when it is odd, the left eye will be photographed. If the eye specified by this algorithm is considered too difficult to photograph with adequate photographic quality, the fellow eye should be photographed instead, and an explanatory note entered in the photography log. Conditions falling into this category are (based upon the technician's judgement): eye missing, inability to dilate at least 4 mm, inability to fixate adequately for proper photographic field definition, and opacities of the media preventing a reasonably clear view of the retinal vasculature and "other". The participants pupil diameter will be measured and recorded at the time of photography.

4.1 **Subject Exclusion**

The photographer will attempt photography on subjects with poor visual acuity who may be unable to direct their gaze so that their nerve is properly positioned in the field alignment circle (as may be the case where both eyes are blind or when the subject is deaf and communication with them is difficult). In these cases, the photographer should get the best field definition possible remembering that it is better to have the nerve closer to the center of the picture than off too close to the edge. Additionally, the optic nerve can be displaced up or down by about ½ DD (disc diameter) and still provide useful information. If, in the photographer's judgement, no acceptable photograph can be taken, the subject will be excused from photography.

The photographer should attempt photography on those subjects who are physically disabled, to the extent that they can be comfortably positioned at the camera. To facilitate this, the subject may remain in a wheel chair positioned before the motorized camera table lowered to the appropriate height. Care should be taken when lowering the camera table to avoid pressing against the subjects legs. If, in the photographer's estimation, the subject cannot be comfortably positioned, no photography will be performed.

4.2 **Pre-examination Procedure**

Before attempting photography, the photographer should become very familiar with the camera through a training session and by learning the terminology on pages 3 - 4 and 24 of the Camera Operation Manual. The following protocol uses terminology from the Operation Manual and it is recommended that the entire manual be reviewed by each photographer performing photography.

The retinal camera should remain covered when not in use. High humidity or temperatures must be avoided. Dusty conditions mean that the camera will need frequent cleaning. The objective lens should be checked and loose dust removed with compressed air or the burst of air from an air bulb if necessary before each subject is photographed. A more extensive cleaning is required to remove grease, smudges or stubborn spots from the lens. This cleaning requires removal of the lens "boot" and external alignment lamp ring and should be referred to the chief photographer at each field center.

4.2.1 Subject Explanation and Informed Consent

Photography begins with a complete explanation of the procedure by the photographer. A Polaroid print may be useful to show what the optic nerve and retina looks like. It is important to reassure the subject that no retinal damage is caused by this procedure. The camera flash is bright and the subject should know when to expect a flash. The pictures will include the macula (area of central vision) and it is normal to experience a blue or red tint to vision immediately following the flash. This disappears within five to seven minutes. No dilation drops will be used for this examination, and the eyes will not be touched. A sample script of a typical retinal photography explanation (suitable for use as written material for deaf or interested subjects) follows.

> *We will be taking a photograph of the inside of the back of one of your eyes (the retina) so we can study the blood vessels and look for any unusual changes. We will not be touching your eyes or be giving you any eye drops to take the picture. Instead, you will be asked to sit in a darkened room before a special camera with your chin in a chin rest. We darken the room so that your pupils will dilate and we can align and focus the camera on your retina. While your pupils are dilating, we may ask you some questions about your vision and the health of your eyes. During the aligning process you will only be aware of some small red lights and a blinking green light visible in the camera lens. We will ask you to follow the blinking green as we move it. Just before we take the picture, we will ask you to blink your eyes and then open them real wide. The camera will flash a bright flash from within the camera lens as the picture is taken.*
>
> *Just after the picture is taken, you may see a blue or red circular spot before the eye photographed. This will disappear within 5-7 minutes and causes no permanent damage to the eye. Please remember that we are only taking one picture*

(not an x-ray) of a small portion of one of your eyes and that this picture will not substitute as an eye examination. You will certainly be notified should we notice anything requiring immediate attention. Please continue to see your eye doctor on a regular basis for your complete eye examinations.

4.2.2 Completing the Retinal Artery Examination Form

Before photographing the subject, the photographer completes the first part of the CHS Retinal Artery Examination Form (Example 5), which concerns the subject's ophthalmic history. The second part of the form records the circumstances of the photographic session, and can only be completed as the session begins. Part of the form can be completed while the subject becomes sufficiently dilated to be photographed. This will depend upon adequacy of ambient light for the photographer (to be able to read questions and record answers) and upon the time required to answer the questions. In particular, if the assigned eye cannot be photographed for a reason gathered during the ophthalmic history (e.g., that eye has been enucleated) or for a reason that emerges during the first part of the session (the assigned eye does not dilate sufficiently well to be photographed), the photographer indicates that the other eye has been selected and the reason for departing from the assignment. For logistical reasons, this form will be completed as a paper form, and later entered into the computer system.

4.2.3 Preparing the Camera

The video display is activated when the power switch on the side of the main unit is turned on. If no photography or switch operations are performed for 10 minutes, a power saving mode is activated, turning the lamps and display off to prevent unnecessary wear. During this power saving mode a "ready" lamp blinks on the monitor. Pressing any button below the arrows under the monitor, the joystick trigger, or the alignment button will reactivate the system.

Notice that three vertical arrows blink on the monitor when the main unit is switched on. This indicates the system is charging up. **Do not take photographs until the blinking stops, indicating a fully charged flash.** Pictures taken before the flash is fully charged will be severely underexposed.

The current date and subject ID number are displayed in the upper left-hand corner of the monitor. The camera contains an internal clock and the date will automatically change each day. The photographer must manually change the date if this clock should fail or if the camera is left unplugged for a long period of time. The date and time display is changed through Menu 3. The date format will read Month-Day-Year. The "Time Set" screen is used to adjust the current date and correct time. The camera is capable of recording a six-digit subject ID number (the CHS ID number with the field center number truncated), accessed through Menu 3, which **must be reset for each subject photographed.** Once properly entered into the camera, the number will appear below the date on the monitor. **This number must be checked and adjusted before each subject is photographed because**

this information is recorded on each slide and will become a permanent part of the data slides and will become the primary identifier for each picture.

The 35mm camera body should be attached to the main unit and loaded with a fresh roll of Professional Ektachrome 100 EPN color slide film (36 exposures). The photographer needs to check that film is indeed loaded in the camera at the beginning of each photography session. The frame counter on the top of the camera will indicate the number of exposures taken. After 36 pictures are taken, the camera automatically rewinds the film. If the film needs to be removed before 36 exposures have been taken, a manual rewind button on the 35mm camera back (page 30 of the Operations Manual) needs to be depressed.

To load the camera, open the camera by sliding the camera latch down while pressing in on the cover lock button. Insert the new film cartridge in the left side and thread the film across the shutter to the right side, making sure that the film leader is aligned with the orange index mark. Be careful not to poke the shutter blades with a finger because damage to the blades can easily occur. Take up any slack in the film by sliding excess film back into the cartridge. Close the back; the camera automatically threads the film and advances the film and counter to the number one exposure position. A blinking "check film back" warning on the monitor or blinking film marks on the camera back LCD display indicates the film is not loaded properly. In this case, reload the film. When the film is properly loaded, the camera back "reads" the film speed and automatically adjusts the flash output. At this point the photographer must press the "DSP" (for "display") button below the monitor to confirm that the following settings are correct:

BACK : RE 100 45 (35mm EOS body, 100 ASA, 45-degree field) A F : O N
(autofocus on)
AE: ON (autoexposure on)
BLINK: ON (blink detector on)
SPLIT: IN (split focus detector in)
NO: H 000001 (6-digit CHS subject ID[1])
DATE : MM-DD-YY 12:00

The photographer will keep a manual film log on the CHS Retinal Photography Log Form (Example 1) kept in the camera room. This log file will include: film roll number, frame number, date, photographer ID number, subject name, subject ID number, eye photographed, and a comments section. Each roll of film will be assigned a unique roll number and will contain photographs of 36 subjects. Once a roll is completely exposed, it is removed from the camera and identified with a film roll number label for identification during processing and mounting.

4.3 Subject Photography

The "H" before the subject ID number stands for "Hold," i.e., the camera holds the number until it is changed to another (rather than "C" for counting up automatically after each exposure). This letter is *not available* to be set to the code for the CHS field center.

4.3.1 Subject Positioning and ID Entry

The subject and photographer are seated on the appropriate sides of the retinal camera. The subject is positioned so that he/she is comfortable with chin and forehead in the headrest. Chin height should be adjusted so that the eyes are approximately level with the height adjustment mark on the face rest pole. The room is darkened to the level where a newspaper can barely be read (equal to about 5 lux) and the camera room door is closed. The only light in the room should come from the display monitor. If a red lamp is used to aid the examiner during administration of the questionnaire, it must be turned off when photography is performed. While the subject's pupil begins to dilate, the photographer enters the last six digits of the subject ID (minus the prefix identifying the field center) into the camera via the number pad on the control panel, so that this can be imprinted at the edge of the photographic frame along with the date when the photograph is taken. After the number is entered, the photographer pushes the "DSP" button (explained above) to display the current camera values on the monitor, so that accuracy of subject ID entry can be checked.

4.3.2 Pupil Size and External Eye Alignment

The camera stage holding knob is unlocked, the alignment switch is turned on and the stage is moved to center the eye to be photographed horizontally and the height adjustment ring is used to position the eye vertically. The pupil should appear on the TV screen coincident with the central circle on the monitor. The camera joystick is moved forward or back until the pupil appears perfectly round. At this point, proper external alignment has been achieved. A pupil larger than the central 4mm circle on the monitor is required for adequate photography. If the eye assigned for photography does not dilate to at least 4mm after a 5-minute waiting period, the fellow eye should be examined for pupillary dilation as well. If dilation of the fellow eye is larger, the photographer will photograph it instead of the selected eye. At this point, the pupil size is measured using the alignment circle on the monitor as a guage. This measurement is estimated to the nearest 1mm and it is recorded on the Photography Log Form.

4.3.3 Fellow Eye Selection

For methodological reasons (approximately random and equal inclusion of right and left eyes) photography should be performed in the assigned eye whenever possible. The fellow eye should be selected only if characteristics of the assigned eye prevent a reasonably clear view of the retina. Such factors include poor pupillary dilation, as specified above, and substantial media opacities, including lens cataract, corneal irregularities, and opacities in the vitreous (e.g, vitreous hemorrhage). Asymmetry of any other type (e.g., the fellow eye has more or less retinal pathology than the assigned eye) should be ignored when selecting the eye to be photographed. If the fellow eye is selected, an explanatory note must be written in the Photography Log Form.

4.3.4 Photography Through Small Pupils

The photographer will experience more difficulty attempting photography through small (less than 4mm) pupils because not all of the camera's light can enter through the smaller pupil. This usually results in uneven illumination (seen as dark shadows) on the monitor. In this situation, the photographer must make careful camera adjustments to position the shadows as far away from the optic nerve as possible.

A small percentage of participants' eyes don't dilate the minimum 4mm required for adequate photography. Certain medication may prevent any dilation and the pupil size observed on the monitor may be 1-2mm, inadequate for the photographer to appreciate any retinal landmarks on the viewing monitor.

If no landmarks are visible, the photographer should adjust the camera slightly to position the corneal reflection dots **slightly above or below their optimum position**. This technique allows a portion of the illumination light (which falls on the iris when the pupil is small) to enter the eye. If any retinal landmarks become visible with this technique, a picture should be taken. However, if no retinal landmarks are visible, which is often the case when dilation is less than 1.5mm, no picture is taken and the fellow eye is examined for dilation instead.

4.3.5 Exposure Compensations for Small Pupils

Photography of participants who don't dilate adequately (to at least 4mm) will be photographed with an increased flash intensity to prevent underexposure. To accomplish this, the photographer will press the "RE N" button under the main screen until a "+" appears in place of the "N" thus indicating a 1/3 f-stop increase in exposure.

4.3.6 Internal Eye Alignment

Once proper external pupil alignment is achieved, the alignment switch is pressed to provide a view of the fundus, split focusing lines, corneal reflection dots, and the fixation light. If no split lines are seen, the height or left/right adjustment is improper, the "SPLT" (split lines) setting is set to "Out" (Menu 1), or the diopter compensating slider is pulled out. The split lines may fade in and out if the pupil is too small, the alignment of the camera is not centered on the pupil, or if the eyelashes or lids eclipse the light. If no corneal reflection dots are seen, the forward/backward adjustment is improper. **The best photographs are obtained when the eye is well dilated, fixation is on the target, and lids and lashes are held wide open.**

4.3.7 Focus with High Myopia or Hyperopia

The diopter compensation slide should be set to the "0" position for most eyes. This is the only setting in which the auto-focus mechanism works and allows photography of eyes with refractions between -12 and +15 diopters. In the event that the eye photographed falls outside this range and auto-focus cannot be achieved, as in the case of aphakia (absence of lens in the eye) or high myopia, the diopter compensation slider must be

adjusted for the clearest focus to the "+" or "-" position and the focusing knob is then turned manually to provide the sharpest image on the monitor. This can be facilitated by obtaining a brighter retinal image on the monitor by increasing the view light intensity. The normal setting for the view light intensity adjustment is approximately 4.

Standard TV monitor functions can be adjusted for the photographer's viewing comfort (including contrast and brightness) by opening the access door below the TV monitor. These are standard controls similar to those found on a home TV set and only effect viewing; they **do not** effect final photo quality.

4.3.8 Alignment, Focus and Proper Fixation

While viewing the fundus image on the screen, the photographer carefully adjusts the internal fixation target lever to position the optic nerve head (also called the optic disc) correctly on the screen. To facilitate consistent position of the optic disc, an aligning mask with two circles has been added to the monitor. When the right eye is correctly positioned on the monitor, the disc falls into the right-hand circle. When the left eye is correctly positioned on the monitor, the disc falls into the left-hand circle. These aligning masks are provided by the Retinal Reading Center and, when properly attached to the monitor, they position the optic nerve centered from top to bottom and the nasal edge of the optic nerve falls between 1.50-2.00DD from the nasal edge of the photograph. If the photographer experiences difficulty placing the optic disc within the proper circle, it is preferable to have the disc shifted towards the center of the photographic field. Final confirmation of proper mask position is made at the Reading Center by measuring the optic nerve position on processed slides (not on the monitor).

Any fine adjustment of subject fixation is made by moving the fixation lever and instructing him/her to look into the lens of the camera at the green target light. In the event that the subject sees no fixation light with the eye being photographed, the photographer must carefully instruct the subject to make micro movements (fine movements up, down, left or right) until the disc falls into the appropriate circle.

Once the fixation is confirmed, the photographer must constantly adjust and position the camera to maintain the correct position of the corneal reflection dots. It is important that these dots be properly positioned at the three and nine o'clock positions before the picture is taken. This will ensure the correct distance from the eye and will allow a sharp image to be produced on the film. Focus is done automatically but should be confirmed by the photographer by assessing image sharpness and by checking the auto focus confirmation indicator (see page 18 of the Operation Manual) on the monitor.

4.3.9 Focusing Manually When The Auto-Focus Mechanism Doesn't Lock

When the auto-focus mechanism focuses the camera on the retina, a motor adjusts the focus knob until the auto-focus "locks" and a clear image is identified. This "lock" is confirmed in two ways. Two vertically stacked equal signs appear in the lower left-hand corner of the screen. Also, two

rectangular boxes appear, stacked one on top of the other, in the center of the monitor.

If the operator notices that the auto-focus mechanism can't "lock" (obvious when the motor keeps running for several seconds and then shuts off) or if the mechanism "locks" without stacking the vertical boxes, he/she should manually focus the camera by turning the focus knob until the two rectangular boxes in the middle of the monitor appear stacked. This method of assisting the auto-focus mechanism will help assure the most accurate focus possible.

The photographer will instruct the subject to blink once or twice just before the picture is taken. This blinking will insure a moist (and subsequently clearer) cornea and will safeguard against unwanted blinks at the moment of exposure. Once alignment is satisfactory, the shutter release, located in the tip of the joystick, is depressed and the exposure is made. Only one eye on each subject is photographed.

4.3.10 Automatic Blink Detection

The Canon fundus camera is equipped with an automatic blink detection sensor to help prevent missed retinal photographs due to an unexpected blink at the moment of photography. When the detector senses an obstructed retinal image, the camera trigger fails and no exposure is made. An error message indicating that a blink was detected is displayed on the monitor and the photographer must repeat the photography procedure.

4.3.11 Retake Policy

Should the photographer suspect that an inadequate photograph was taken (due to a possible blink, shadow, excessive movement or mis-alignment) or should the subject comment that they blinked or did not see the flash, the size of the pupil should be checked (a larger pupil indicates that no light reached the eye) and a second picture should be taken. In this situation, the best picture is sent to the Retinal Reading Center.

5 LOGS AND RECORDS

5.1 **Photography Log Form**

A daily Photography Log Form (see Example 1) will be maintained for each roll of film to provide an accurate listing of each subject photographed. The complete log for each film roll will contain the film roll number, frame numbers, date, photographer ID number, subject ID number and acrostic, eye photographed, and a comments section. The film roll number will be of the form XYYY, where "X" indicates the CHS field center number (between 3 and 6 inclusive) and "YYY" indicates the number of the film roll for that field center. That is, for a given field center, the first film roll number will be of the form X001, the second film roll number of the form X002, etc.

The comments section of the Photography Log Form is used to record the pupil size. The photographer is encouraged to comment on anything unusual such as strange artifacts, small pupil size, pathology or other problems.

This information will be helpful in identifying specific photographs, and in understanding any artifacts that may appear on the processed slides. Since comments from the log accompany the photographs to the Retinal Reading Center, staff there can take this information into account when providing feedback.

6 FILM HANDLING

6.1 **Film processing**

The film will be removed from the camera after automatically rewinding as each roll is fully exposed. Film will be processed promptly after a roll of film is completely exposed (preferably at least every one week to ten days). Prompt film processing is essential to help us quickly detect an unexpected camera malfunction or film processing problems. Partially exposed rolls of film may be removed after rewinding the film automatically by depressing the Manual Rewind Button (see page 30 of the Operation Manual). The photographer will attach a numbered film roll label to each exposed roll of film before sending it for processing. The film roll label appears as follows:

CHS Study
Film Roll No._____

The film roll number must correspond with the sequential number appearing on the corresponding Photography Film Log page.

The undeveloped rolls of film will be sent to a reputable Ektachrome processing laboratory[2], preferably three times per week. A record of film sent will be kept and films will be logged out and in so any lost films can be easily recognized and traced. A Film Processing Log (example 2) will be completed whenever film is sent out or received back from processing. Special attention must be paid to the slide cutting and mounting (framing into either cardboard or plastic mounts) to be certain that the date and ID information is located on the left side of the retinal image on the slide with the registration "notch" on the right-hand side.

Film is processed locally so that photographers can review their results as soon as possible for possible camera malfunction. Also, the opportunity for photographers to critique their work is critical to the

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A professional film processing laboratory (i.e., not supermarket or drugstore service) offering consistent and timely E-6 processing for Ektachrome film must be selected. Professional photographers in your area can advise you about the identity of such a laboratory, or the Retinal Reading Center will help you find one.

maintenance of satisfactory photographic quality.

6.1.2 Film sorting and labeling

The processed films will be sorted and labeled using the Photography Log Form as a guide. Extreme care is necessary no avoid incorrect identification and labeling. The pictures will be labeled with pre-printed slide identification labels. To make them easy to locate, labels will be printed in batches by the field center computer in date and subject ID order. The individual slide labels contain the participant ID number, acrostick (name code), study acronym and a space to record the pre-photography pupil size, measured to the nearest millimeter. Slide labels appear as follows:

ID: 3004567

Pupil_____mm

NEIDMW

CHS

6.1.3 Slide mounting

The sorted and labeled slides are loaded into Bardes plastic slide pages so that each row contains two photographs, thus only columns 1 and 3 are used. The mounting pattern is diagramed in Example 3. Slides are mounted in the order taken and developed. The proper order is confirmed by comparing the slides with the corresponding Photography Log Form for each roll of developed slides. A roll of film of 36 exposures would result in 4 sheets of photos, specified as sheets 1,2,3 and 4 with only 6 slides in the final sheet.

6.1.4 Photo Shipping

Packages of processed, mounted slides and the relevant Photography Log Forms are sent weekly to Judy Brickbauer at the CHS Retinal Reading Center, under cover of the shipping list (Example 4). The shipping list identifies the field center, shipping batch, number of mounted sheets, number of retinal photographs, shipping date, a comments section and the person preparing the shipment. The Reading Center will use these forms to verify the receipt of shipments, noting the date the photos are received and the name of the person checking the shipment. After the Reading Center receives each shipment, a receipt confirmation card is sent back to the field center confirming safe arrival of the shipment. A sample format for this postcard is diagramed below:

6.1.5 Shipping Envelopes

The Reading Center recommends the use of plastic lined air bubble mailers similar to the Avery "Post-Lite" or the Jiffy "Jiffylite". These are available in a variety of sizes and do not contain the recycled fiber padding prone to shed dust and dirt on the slides. Please be sure to put the plastic slide pages in a manila folder to prevent the sharp edges from cutting through the mailing envelope. The standard Federal Express or UPS envelopes, reinforced with a manila folder around the photos, are also acceptable.

6.1.6 Shipping Couriers

When using couriers such as Federal Express or UPS, please use the Retinal Reading Center's complete street address. Address information can be found under Section 8 on pages 18 and 19 of this protocol.

7 QUALITY CONTROL

Photographic quality will be continuously monitored throughout the study. Initially all photographs will be reviewed by the Photography Consultant. Feedback will be provided to the photographers in cases that warrant critique on a weekly basis for the first month of the study, monthly thereafter. A telephone call or letter will be used detailing problems and suggesting improvements. Once the study is well underway and the photographers sufficiently trained, data on quality will be generated from the photograph readers' evaluations of all photographs. A small percentage of the photographs will be reviewed by the Photography Consultant each month, and feedback will be provided to the photographers in cases that warrant critique.

In order to assess variation within and between photographers, each site will need to perform repeat retinal photographs on 50 subjects, approximately one per week per site during the course of the CHS study year (with a maximum of 3 repeat retinal photographs performed each week throughout the CHS study year). Only two photographers at each site will be involved in performing both the original and repeat photographs for subjects agreeing to

CHS Study

CHS Photo Shipment Receipt Card

Field Center _____
Batch Identifier _____
has been received at the Reading Center on _ __-/___/___

Comments _____

undergo repeat retinal photographs. The CHS Coordinating Center will designate the photographers involved in the Retinal repeatability study during the initial 4 weeks of the CHS study year (denoted as Photographer A and Photographer B in the following). After the photographers have been designated, approximately 13 subjects will have both of their retinal photographs taken by Photographer A, and approximately 13 subjects will have both of their retinal photographs taken by the Photographer B. In addition, approximately 12 subjects will have their first retinal photograph taken by Photographer A and their second retinal photograph taken by Photographer B, with an additional 12 subjects having retinal photographs first taken by Photographer B, then by Photographer A .

Upon termination of the initial retinal photography session performed by Photographer A or Photographer B, and on a day where both designated photographers are available, study subjects should be asked if they would be willing to undergo a second photograph of the same eye after the completion of their clinic visit. Sites should attempt to perform repeat retinal photographs on at least one subject each week. In order to process the second retinal photograph, a list of "fake" CHS IDNO's will be provided to the sites, as was done for the repeatability study on Pulmonary Function. These "fake" IDNO's will be used on the slide labels and Photography Log Form, and, of course, should also be entered into the camera prior to retinal photography for all subjects involved in the repeatability study.

8 PHOTOGRAPHER CERTIFICATION

Each examiner taking fundus photographs will need to become certified before taking photographs for the study. The initial group of photographers will receive didactic and hands-on training at their individual sites. The Reading Center Photographic Consultant, Michael Neider, will travel to each site to help install the photographic equipment and train photography staff. Following the training, each photographer will practice taking photographs and prepare photographic sets for submission the Reading Center for certification. A photographer is fully certified after submitting satisfactory quality photographs of 10 eyes taken on non-study volunteers. These photographs must show proper field definition, exposure, alignment and focus. The photographs must be completely labeled and mounted according to protocol. Upon certification, the Reading Center will issue a photographer certification number to be used on the CHS Study Photography Log Form.

As additional personnel need training to become certified, a certified photographer at that center will provide complete instruction and copies of the protocol and Operation Manual. The trainee photographer will practice on volunteers and, when ready, prepare and submit photographs of 10 eyes for consideration for full certification.

CHS Study Photography Log Form Film Roll Number _____

Frame	Date	Ph/ID	Subject ID #	Eye	Pupil Size and Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					

Example 1

CHS Study Photography Log Form Film Roll Number _____

Frame	Date	Ph/ID	Subject ID #	Eye	Pupil Size and Comments
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					

Example 1

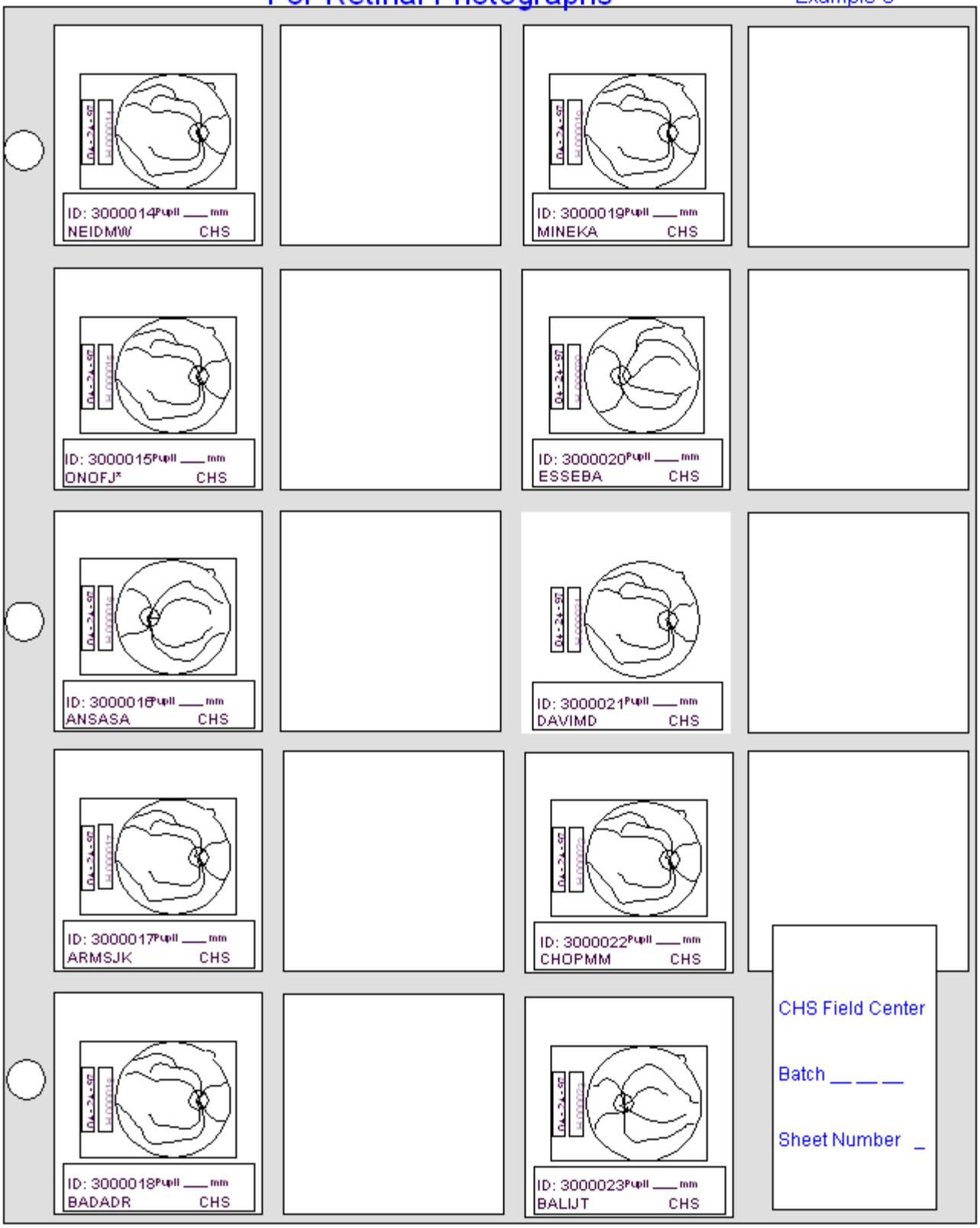
CHS Study Film Processing Log

Roll #	Date Out	Date In		Roll #	Date Out	Date In

Example 2

CHS Study Slide Mounting Diagram
For Retinal Photographs

Example 3



Clinical Center: University of California - Davis

Shipping Batch: ___ ___ ___

Number of Mounting Sheets ____ Number of Retinal Photographs _____

Date Shipped ___ ___ / ___ ___ / ___ ___Person Shipping_____

Retinal Reading Center use only.

Date Received ___ ___ / ___ ___ / ___ _____Person Receiving _____

Photo receipt confirmation card sent _ _/_ _/_ _

Comments _____

Example 4