University of Wisconsin
SCHOOL OF MEDICINE
AND PUBLIC HEALTH

Fundus Photograph Reading Center

4-Wide Field
Digital Color Fundus Photography
(4W-D)

Effective Date: *24 May 2011*

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1. 4W-D Overview

This document details the Fundus Photograph Reading Center (FPRC) procedure for photographer certification, provides instruction to image the 4-Wide Fields (4W-D) and lists pointers on imaging technique.

This document also provides information and references for digital system certification and export of study images. Digital systems must be certified for each study separately. See the *Digital System Certification* document for further details. The preferred method of image export is by electronic submission using the FPRC Portal. See section *5.1 Electronic Submission Using the FPRC Portal (*Preferred). Export using CD/DVD is also acceptable. See section *5.2 CD/DVD Submission.*

Further clarification regarding any information included in this document may be obtained by contacting the FPRC Imaging staff at (608) 410-0619 or by sending an email to Imaging_administrators@rc.ophth.wisc.edu.

2. Photographer Certification

2.1. Overview

Photographer certification is specific to each study, and photographers taking digital images for studies evaluated by the FPRC must be certified for the relevant procedure(s) before submitting actual subject images. See section *2.4 Uncertified Photographers* for situations where uncertified photographers may be used.

The certification images may be taken on subjects being photographed for clinical purposes or of volunteers. Once a photographer is certified for a specific study, he/she is certified for the duration of that study, provided he/she meets the quality standards set by the FPRC. See section *6 Evaluation of Image Quality*.

2.2. Certification Requirements

Certification consists of:

- Review of the study synopsis/protocol and imaging procedure(s)
- The ability to perform the imaging procedure(s), demonstrated by the submission of images of acceptable quality

2.2.1. Images Required if Previously Certified

The second certification requirement listed above will be waived if all of the following criteria are met:

- The photographer has prior certification at the FPRC using an identical procedure.
- The photographer has been actively taking images during the past 12 months.
- The images are judged to be of good quality by the FPRC.

If a photographer believes that these criteria have been met or that he/she has been certified by the FPRC for a similar procedure, submit a certification request (see section *2.3 Submission for Certification*) without sending images.

2.2.2. Images Required if Not Previously Certified

Submit a certification request (see section *2.3 Submission for Certification*) and send color images of four eyes (two right eyes and two left eyes) taken using this procedure (4W-D).

2.3. Submission for Certification

Photographers are encouraged to send complete submissions for each procedure for which they are requesting certification (i.e., if four eyes are required for a certification submission, send all four eyes together).

Photographers who meet certification criteria will receive confirmation of certification. Those who do not meet these criteria will receive feedback from the FPRC Imaging consultants and may be required to submit additional sets of images. A plan for improving image quality may be necessary after three complete unsuccessful certification submissions.

2.3.1. Electronic Submission Using the FPRC Portal (Preferred)

To request certification apply online through the FPRC Portal and upload images, if applicable. See https://fprcportal.ophth.wisc.edu/ for login and upload instructions.

2.3.2. CD/DVD Submission

In cases where the FPRC Portal cannot be used, the images should be sent with the completed **Certification Request Form**. See *CD/DVD Submission* document for details about labeling and sending images to the FPRC.

2.4. Uncertified Photographers

2.4.1. Baseline/Screening Visits

Only FPRC-certified photographers are allowed to take baseline (screening visit) photos, unless an exception to this rule is granted (on a case-by-case basis) by the study sponsor. The baseline images for a subject are critical since all follow-up measurements are compared to this point to determine the study outcome.

The sponsor may suspend subject enrollment if the site does not have a certified photographer available to take the baseline images.

2.4.2. Follow-up Visits

On rare occasions during **follow-up** visits ONLY, when a certified photographer is not available, an uncertified photographer familiar with the procedure(s) may take the images. The uncertified photographer should review the imaging procedure(s) before performing photography to be certain he/she understands the procedure and follows the study requirements. Include a comment on the **Transmittal Log** or any

official documentation indicating that the photos were taken by an uncertified photographer and the reason why.

3. Fundus Cameras

Retinal cameras suitable for this procedure will have 50° or 60° magnification settings. Contact the FPRC if you have questions about the camera you intend to use.

4. 4W-D and Fundus Reflex Images

The 4 wide-angle stereoscopic fields for color fundus photography consist of Field 2W centered just temporal to the center of the macula, Field 1W located nasal to the optic nerve (the disc), Field 4W is the superior temporal field, and Field 5W is the inferior temporal field. These fields are illustrated below. See the figures that follow for examples.

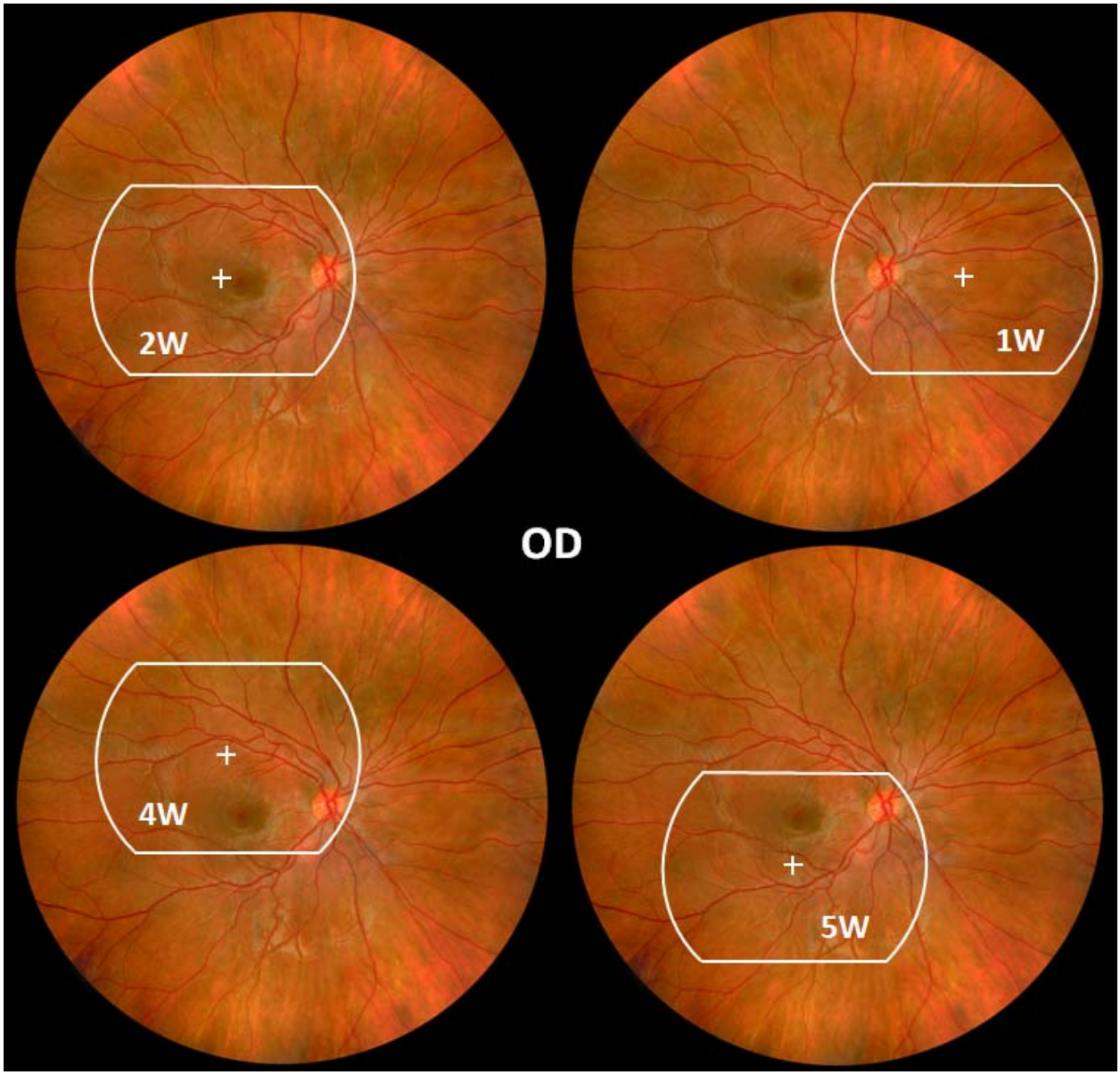
The following descriptions of the standard fields assume that there are two cross hairs in the camera ocular, one vertical and the other horizontal, intersecting in the center.

Field 1W – Nasal Field: The temporal edge of the image is located mid-way between the optic nerve and the center of the macula.

Field 2W –Posterior Pole: The center of the image is just temporal to the center of the macula. Place the cross hairs on the temporal edge of the macula to obtain this field position.

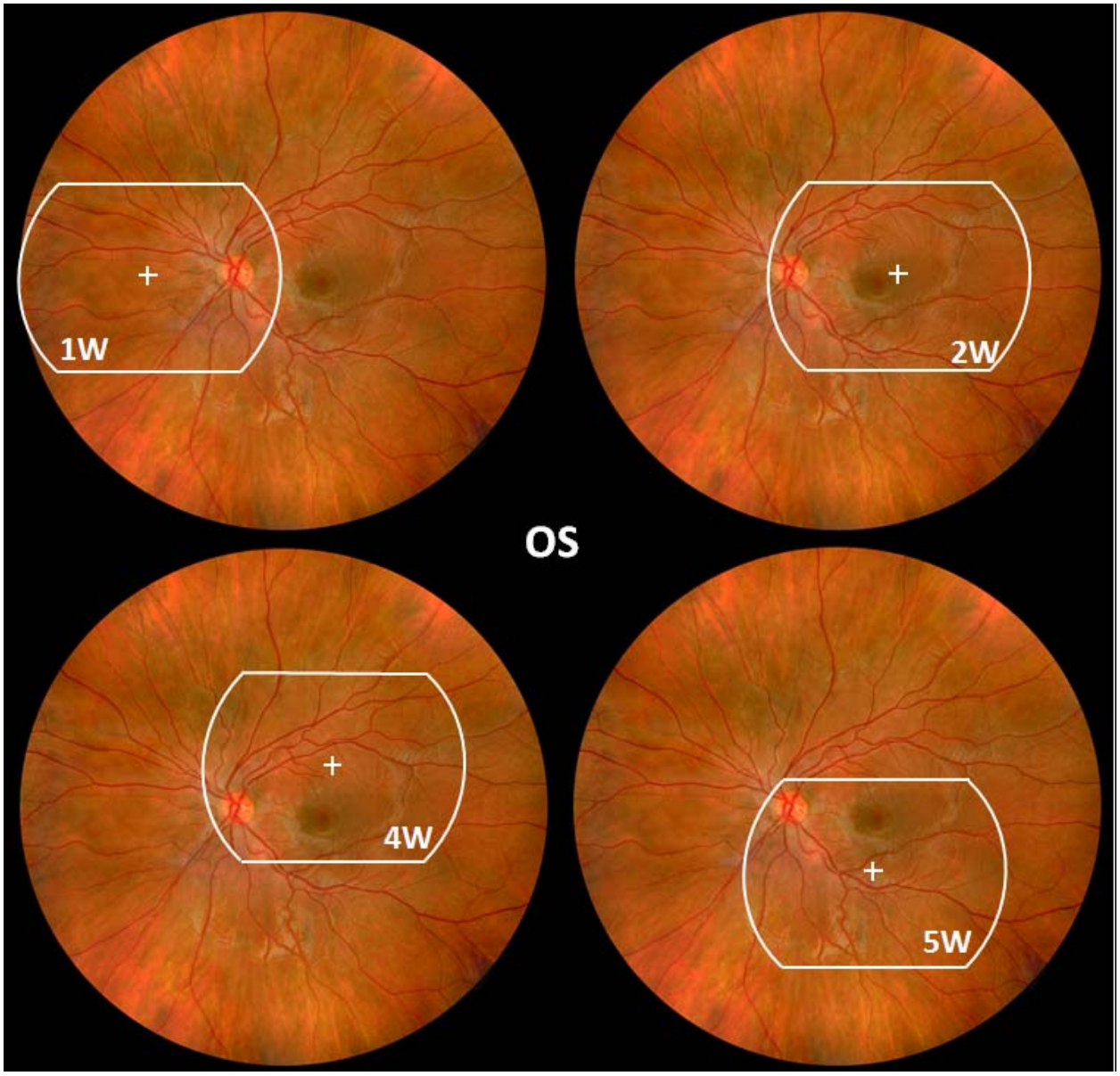
Field 4W – Superior Temporal: This field includes the optic nerve and the macula; the macula located approximately 1DD (disc-diameter) from the bottom edge of the field. The nasal edge of this field is even with the nasal edge of the disc. Note that this field includes both the disc and the macula, and the center of the macula is approximately half way between the inferior border of the image and the center of the image.

Field 5W -- Inferior Temporal: This field includes the optic nerve and the macula—the macula located approximately 1DD from the top edge of the field. The nasal edge of this field is even with the nasal edge of the optic nerve. Note that this field includes both the optic nerve and the macula, and the center of the macula is approximately half way between the center of the image and the superior border.



Fields 1W, 2W, 4W, & 5W – Right Eye

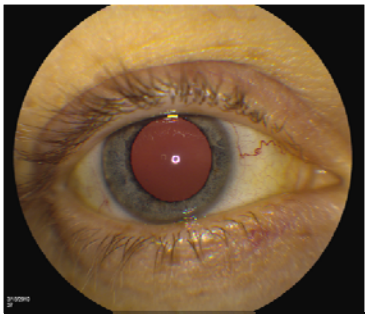
Images courtesy of Richard Hackel



Fields 1W, 2W, 4W, & 5W – Left Eye

Images courtesy of Richard Hackel

At all visits stereoscopic fundus reflex images (an external eye view) should be taken to document media opacities. If no opacities are present, focus on the pupillary margin of the iris. If opacities are present, focus on the lens opacities. The magnification of these images should match that of the image in the figure below. The best stereo effect is obtained by moving the camera laterally about 3mm between exposures. The lateral shift can be obtained by moving the joystick. A fixation target should be positioned to direct the subject's gaze in the primary (straight ahead) position, so the optic nerve *does not appear* directly behind the lens.



Fundus Reflex

5. Submitting Study Images to the FPRC

Images should be saved and sent using no compression or lossless compression (PNG). For additional information on specific image-handling procedures, see the *Digital System Certification* document.

5.1. Electronic Submission Using the FPRC Portal (Preferred)

Digital images may be transferred to the FPRC by uploading them through the FPRC Portal. See https://fprcportal.ophth.wisc.edu/ for login and upload instructions.

5.2. CD/DVD Submission

In cases where the FPRC Portal cannot be used, the study images should be sent with the completed **Transmittal Log**. See the *CD/DVD Submission* document for details about labeling and sending images to the FPRC.

6. Evaluation of Image Quality

6.1. At the Study Site

The color images should be evaluated for quality by the principal investigator and/or photographer (unless prohibited by Study Protocol) before submission to the FPRC. If quality is not adequate for assessment of key features of the study eye (such as extent of macular edema), and if no irremediable cause of inadequate quality is present (such as lens opacities or a pupil that will not dilate adequately), the images should be retaken before submission to the FPRC.

6.2. At the FPRC

Color images of each eye are reviewed and assigned a grade for overall quality. Feedback will be provided to the photographers as needed to help with resolution of any problems. Special attention will be given to photographers having difficulty meeting study photo quality standards. If a certified photographer consistently fails to meet study standards, certification may be suspended.

7. Pointers on Imaging Technique

7.1. General

When shooting the fields, shoot the study eye images first, followed by the fellow eye. Stereo pairs should be taken consistently, usually shooting the left member of the pair first, followed by the right member of the pair. All images should be reviewed for quality at the time of photography, and the photographer should select the best stereo pairs for each field, deleting extra images.

7.2. Patient Cooperation

Photography of the photophobic subject can be challenging for the photographer and uncomfortable for the subject. Minimizing the number of flashes and the length of time the eye is exposed to a bright viewing lamp are two things that can help make the photography procedure more comfortable. Additionally, keeping the view lamp as low as possible (maybe even dimming the room lights) can help make the photography procedure more tolerable. Patients should be asked to blink frequently to help keep the cornea clear.

If the subject has difficulty tolerating the screening visit photography procedure, and the photographer thinks this will lead to a problem at follow-up visits, the situation should be discussed with the principal investigator and/or coordinator. In such cases, consideration should be given to not enrolling the subject in the study.

7.3. Photo Sequence

When the 4W stereo fields are taken, the following sequence is recommended: posterior pole (Field 2W), superior temporal (Field 4W), inferior temporal (Field 5W) and then nasal (Field 1W). Stereo Fields 1W and 2W may be taken on the same horizontal plane. Stereo fields 2W, 4W, and 5W are taken on the same vertical plane.

This procedure will help us separate images from the right eye and left eye when we view the proof sheets. To obtain stereo pairs that are correctly oriented on the computer monitor for stereoscopic viewing (i.e., do not have reversed stereoscopic effect), the photographer must be careful to shoot the members of each stereo pair in the proper sequence.

7.4. Focus/Clarity

The best image quality is obtained if corneas are not disturbed by prior examination with a diagnostic contact lens. In a properly aligned digital system, the cross hairs and the retina are in focus at the same time. In these instances, constant attention must be paid to keeping

the cross hairs in the camera ocular in focus when focusing on the retinal vessels. However, some digital systems are not par focal with the eyepiece; in these cases, it is important to confirm that the image on the monitor is as sharp as possible. Proper camera-to-eye distance should be maintained to avoid haziness and artifacts.

If it is not possible to get the entire photographic field in crisp focus, the photographer should concentrate on getting the center of the field in focus, sacrificing a bit on the periphery if necessary. *This may involve refocusing from field to field.*

A common problem is focusing below the surface of the retina. It is preferable to focus on fine retinal vessels. It may help to err on the side of focusing slightly above the retina rather than too deep. This should keep both the anterior surface of the retina and the pigment epithelial background in focus.

7.5. Stereoscopic Effect

This photography procedure requires the use of wide angle fundus cameras that have an optical pathway that is generally larger than the standard 30° or 35° fundus camera. **Therefore, optimal pupillary dilation is essential for obtaining satisfactory wide angle image quality.** Dilation of the pupil to at least 6mm is important to permit good quality stereo photography. If the pupils cannot be dilated to at least 4mm for the screening visit, the stereo effect will be minimal or nonexistent.

The technique described by Allen[1] is used for taking non-simultaneous stereo fundus images. The camera **should not be rotated or pivoted**; instead, it should be moved laterally from left to right with the joystick (or by sliding the camera base on its table, if preferred). Try to obtain about 2mm as the minimum separation between members of the stereo pair when moving the joystick or sliding the camera.

Stereo pairs should be taken shooting the left member of the pair first, followed by the right member of the pair. When obtaining stereo pairs, care should be taken that at least one member of the pair is of good technical quality with crisp focus. In many cases, it will be possible to obtain good quality in both members of the pair; but if this is not the case, the aim should be to obtain good quality in one member and some stereo separation between the members, accepting somewhat poorer quality in the second member of the pair, if necessary.

7.6. Exposure, Gain, and Flash

It is important that photographers adjust flash, gain, and gamma to obtain optimal exposure, as well as avoiding severe over- or under-exposure. Over-exposure is more damaging than under-exposure, often resulting in total loss of image detail. We recommend that photographers become familiar with using the camera and software controls available to ensure optimal exposure and good color balance. The most commonly occurring color balance problem we see is an over-saturation of the red channel. The FPRC Imaging staff is available to assist in recommending acceptable settings.

[1] Allen L. Ocular fundus photography. *Am J Ophthalmol* 1964; 57:13-28.

Most digital systems have a wide variety of image enhancement tools to adjust image contrast, brightness, or sharpness after image capture. Enhancement tools should not be used at the clinical site to adjust image quality. Pay careful attention to obtaining optimum exposure and image sharpness so that enhancements are not necessary. For more information on color balance for retinal images, read the Color Balance Paper on our website by clicking on the hyperlink Color Balance of Film Vs. Digital Retinal Images or by going to the Digital System Certification section of the FPRC website (http://eyephoto.ophth.wisc.edu/DSES.html).