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PERFORM Operating Document

Placement of Standard Scalp Electrodes Using the International Ten-Twenty System

PC-POD-FA-003-v02

Revision History

Version	Reason for Revision	Date
01	New POD	February/18/2015
02	Updated lettering in diagrams	April/08/2016

Summary

The content of this PERFORM Operating Document (POD) provides guidelines for:

- Electrode placement of scalp electrodes:
  International Ten-Twenty System (or 10/20 System)

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1. Definition of Terms and abbreviations

C	Central site
EEG	Electroencephalography
F	Frontal lobe
Fp	Frontopolar
Inion	Occipital protuberance
Instructor	Person that has attained an adequate level of certification and expertise which qualifies them to supervise and teach students.
International Ten-Twenty System of Electrode Placement	An internationally recognized method to apply the location of scalp electrodes in the context of an electroencephalogram.
Internship student	An internship student is a current student or recent graduate that is undergoing supervised practical training supervised by PERFORM employees.
Lateral view	Side view of the head
Nasion	Area just above the bridge of the nose
O	Occipital lobe
P	Parietal lobe
PERFORM operating document (POD)	Operating documents that are specific to an instrument or technique that require approval by area managers.
pre-auricular points	Zygomatic notch indentation
Project Lead	The project lead is the person who is responsible for all aspects of a given project at PERFORM
Superior view	Top of the head
T	Temporal lobe
User	Person using space or equipment at the PERFORM Centre that has received adequate technical and safety training.
z	Refers to an electrode placed on the mid- or center line of the scalp

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2. Introduction

2.1 Background

The electroencephalogram (EEG) records electrical activity of the brain. The scalp electrodes record potential differences which are caused by postsynaptic potentials in the membrane of cortical neurons. Scalp electrodes record the summated potential changes of neurons in the underlying cortex. Summation of potential changes in the cortex occurs mainly at the pyramidal cells of the cortex. Scalp electrodes may also record some potential changes generated by distant parts of the brain (thalamus), potential changes outside the brain (interference of the recording equipment) and changes produced by biological activity (eye movements, heart beat and scalp muscle) EEGs are used in clinical settings to document the appearance of seizure activity. When used overnight in a sleep laboratory, it is referred to as a polysomnography (PSG) to rule out a sleep disorder and/or to "score" different stages of sleep.

2.2 Purpose

To establish a POD for the measurement of electroencephagraphic (EEG) scalp electrodes according to the International Ten-Twenty System of Electrode Placement (Jasper H. The '10-20' system. Electroenceph Clin Neurophysiol 1958;10:371-375; American Electroencephalographic Society. Guideline thirteen: Guidelines for standard electrode position nomenclature. J Clin Neurophysiol, 11:111-113, 1994; AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications, 1st ed.: Westchester, Illinois: American Academy of Sleep Medicine, 2007).

2.3 Scope

This POD applies to all users and supervisors using EEG scalp electrodes with the exception of EEG caps (64 channels and more), which have predefined electrode localization, at the PERFORM Centre, Concordia University.

2.4 Responsibility

It is the responsibility of each user to place electrodes according to International Ten-Twenty placement criteria and complete requisite training on EEG. Refer to the research study (and the project lead) to determine study specific application locations

2.5 Equipment

Metric tape measure (use the centimeter side)

- China marker (or surgical marker)
- Hair clips, if necessary
- Non-sterile gloves (or finger cots)
- Alcohol wipe (or alcohol & cotton balls)

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3.0 General Considerations

- Use new china marker, break off tip or wipe with alcohol for each new subject.
- When making marks, make a perpendicular line on both sides of tape measure, then remove tape measure to connect the lines.
- For secondary measurements, tape measure should be centered over existing marks. In order to get the "exact" placement of any site there must always be a cross-section of two intersecting marks.
- All measurements are to be made in centimeters (cm). The numbers '10 and 20' refer to the distance in percent (10% or 20%) between adjacent electrodes.
- Wipe down tape measure after use with alcohol.
- Each electrode site is identified by a letter (Frontal, F; Temporal, T; Central, C; Parietal, P and Occipital, O) and a number (Left hemisphere: odd number 1, 3, 5, 7; Right hemisphere: even number 2, 4, 6, 8) to identify the lobe and hemisphere location, respectively (see Figure 1). Note: Central, C is used for identification purposes only.
- Before making measurements, refer to Figure 1, Figure 2A and Figure 2B below.

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Figure 1: International 10-20 System with hemisphere location.

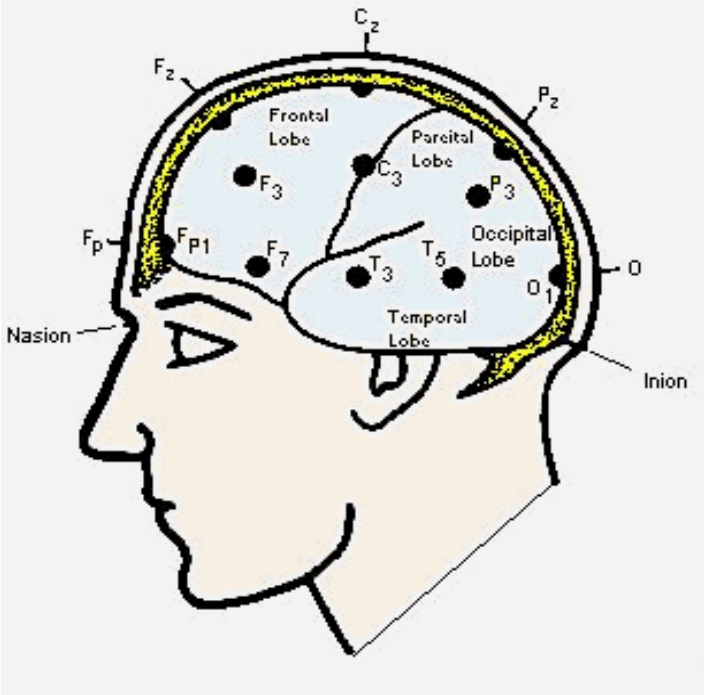
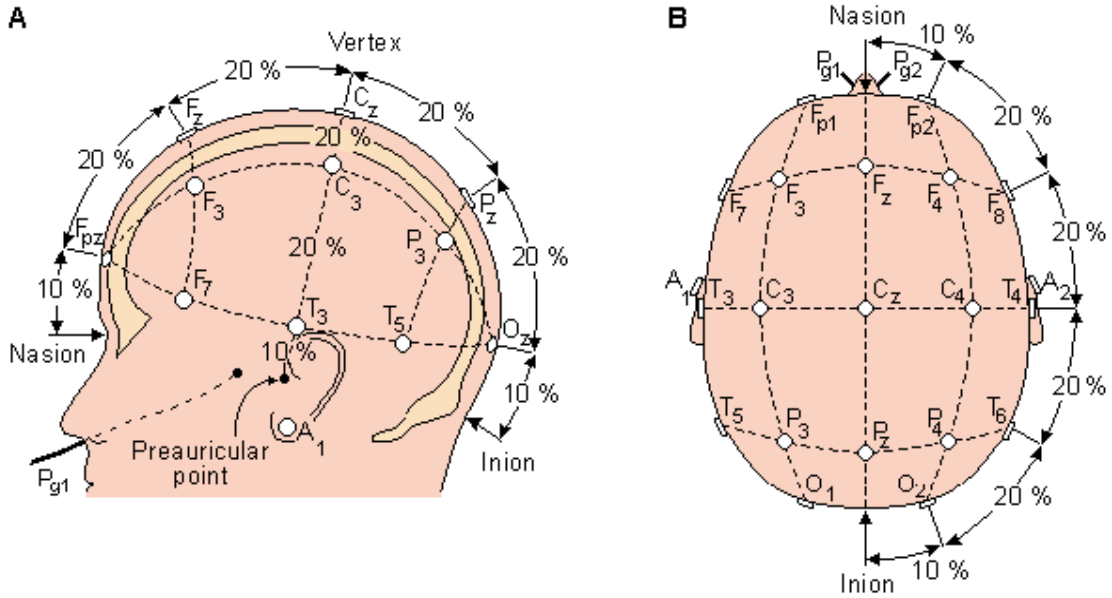


Figure 2: Summary of the International 10-20 Electrode Placement. (A) Left lateral view. (B) Superior (or above the head) view.



Herbert H. Jasper (May 1958). "Report of the committee on methods of clinical examination in electroencephalography: 1957". *Electroencephalography and Clinical Neurophysiology* **10** (2): 370–375.

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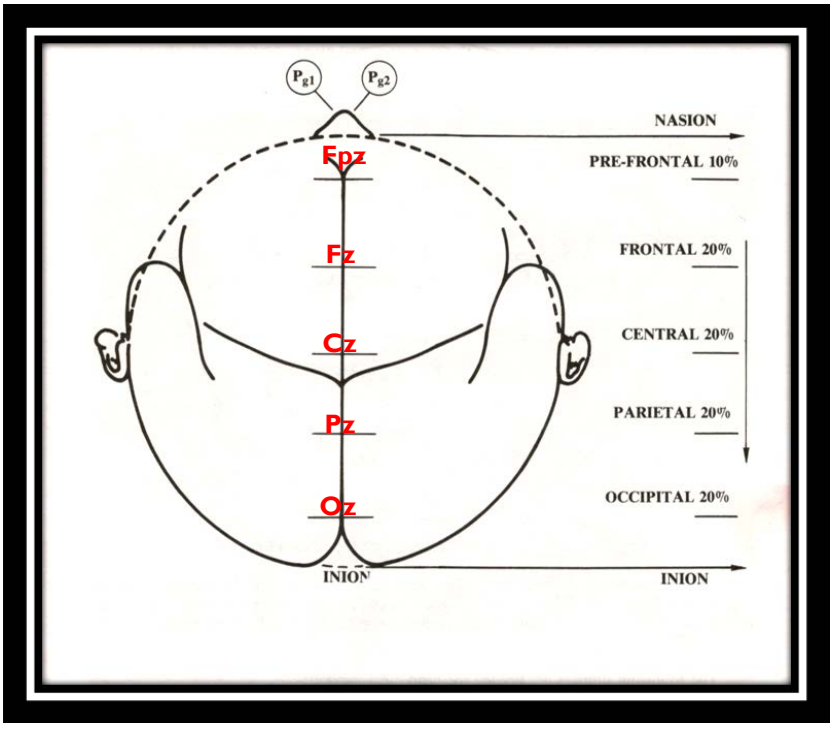
4.0 Procedure

Prior to placing the electrodes on the scalp, clean the scalp at each electrode site by rubbing each spot with a cotton ball dipped in rubbing alcohol or an alcohol wipe. Locate the four landmarks: nasion, inion, left and right pre-auricular points.

4.1 Step 1. Midline

- Measure over the nasion-inion distance (N-I).
- Mark 50% of the N-I distance (central, Cz mark).
- Mark up 10% of the N-I from the nasion (pre-frontal, Fpz mark) and inion (occipital, Oz mark).
- For additional midline measurements, mark 20% of N-I distance anterior and posterior of the Cz mark. These are the first marks for frontal, Fz and parietal, Pz, respectively.



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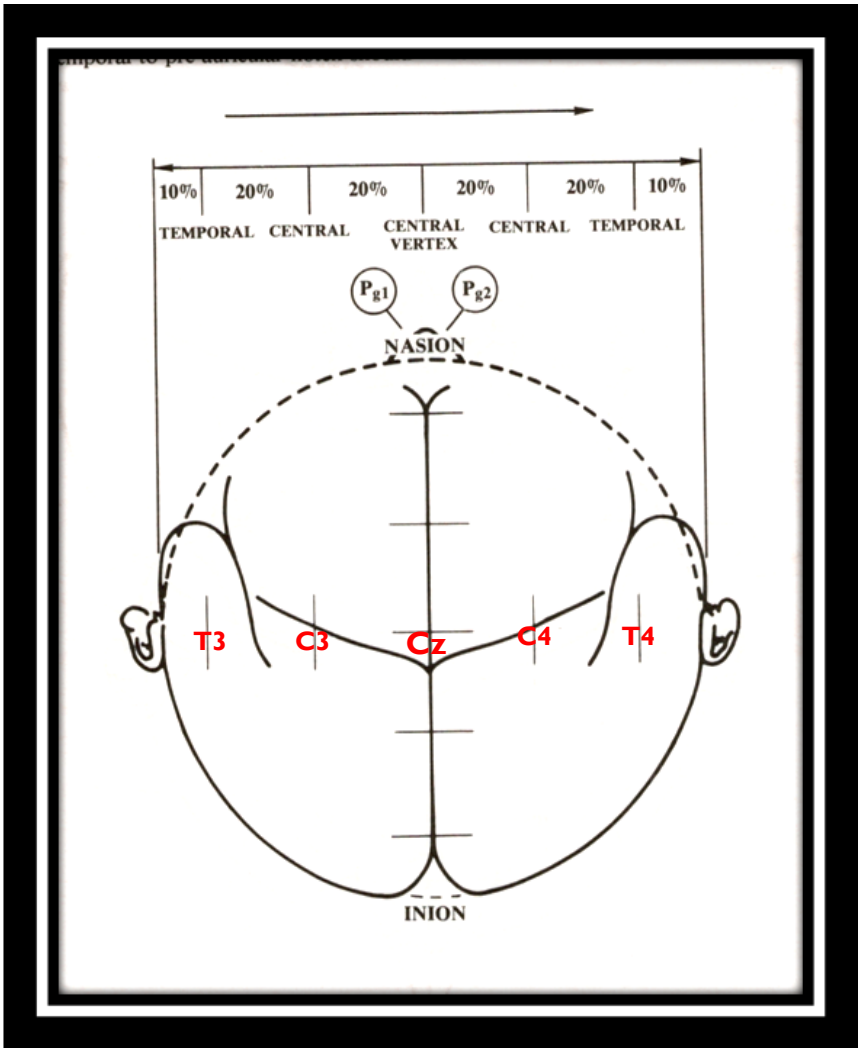
4.2 Step 2. Pre-auricular

- Measure the **left-to-right** pre-auricular distance (P-P), with the tape centered over the N-I 50% mark.
- Mark 50% of the P-P distance making sure tape is still centered over the 50% mark of the N-I distance. This intersection (+) is site **Cz**.
- Mark up 10% temporal (T3) of P-P from the **left** pre-auricular point. Measure 50% from temporal to Cz (central, left C3 mark).
- Repeat for the **right** pre-auricular point for the T4 and right C4 marks.



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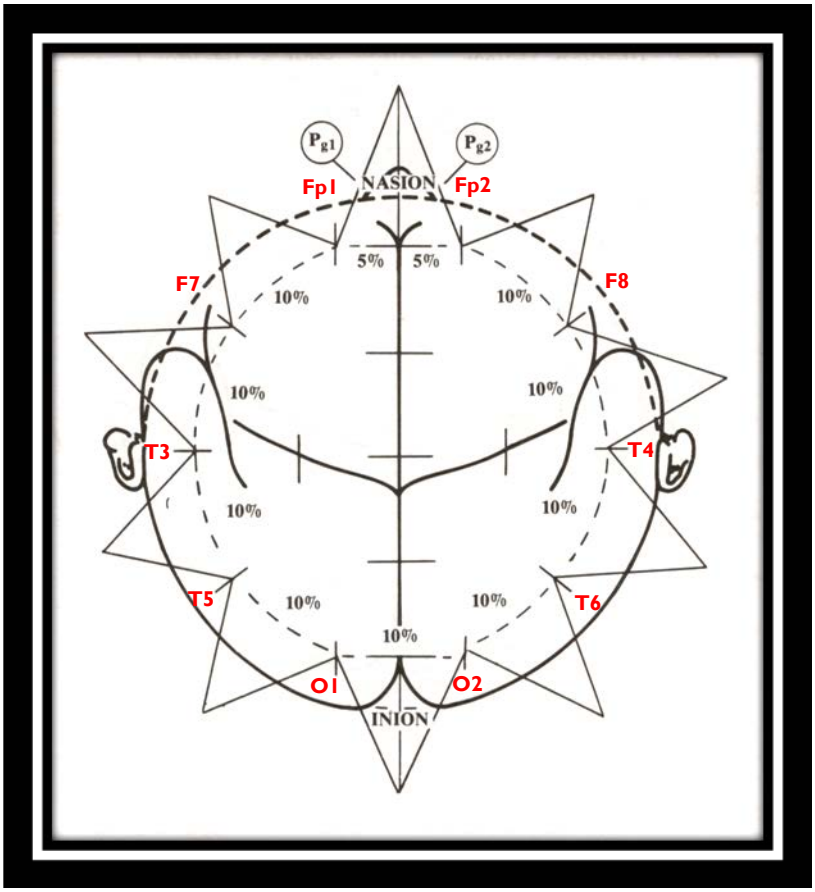
4.3 Step 3. Head circumference

- Make a mark (cross hair +) on Fpz above the nasion.
- Measure the *head circumference* (CIR), centered through the already measured 10% marks.
- Making sure the tape is still centered over the four 10% marks, mark 50% of the CIR. This intersection is site Oz.
- Mark 5% of the CIR to the left and right of Oz. These intersections are occipital sites **O1** (left) and **O2** (right) above the inion.
- Mark 5% of the CIR to the left and right of Fpz. These intersections are pre-frontal sites **Fp1** (left) and **Fp2** (right) above the nasion.
- Measure and mark 10% CIR from Fp1 to O1 (left **F7, T3, T5** mark). Repeat for the opposite side using Fp2 to O2 (right **F8, T4,** and **T6** marks).



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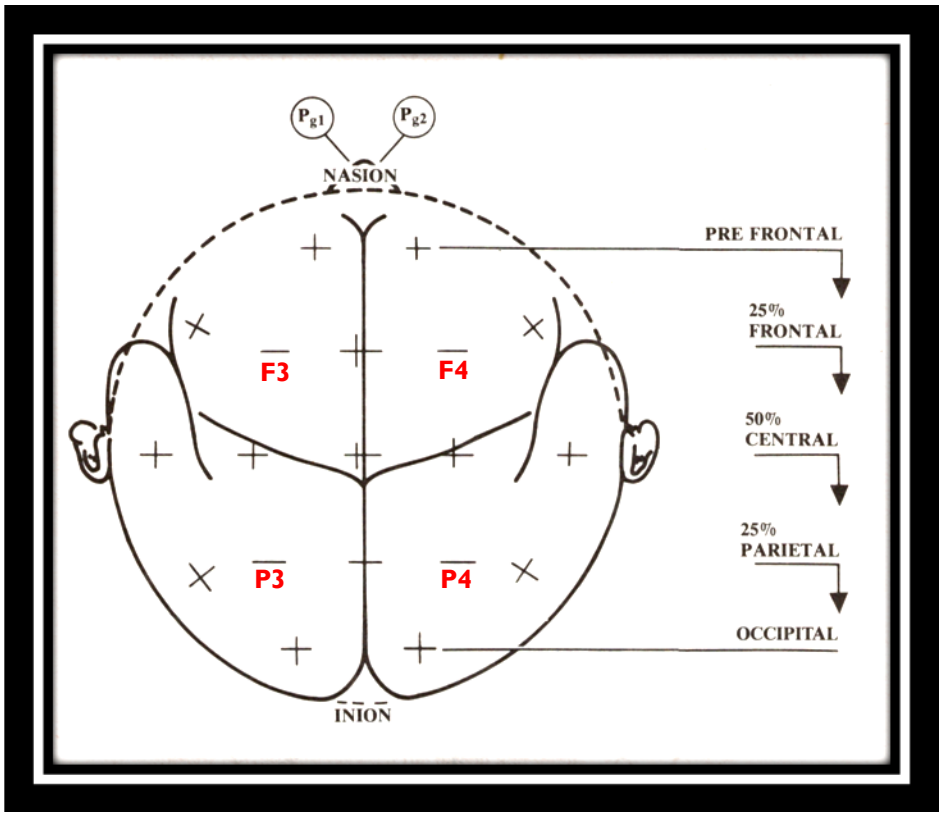
4.4 Step 4. Sagital

- Measure and mark half the distance or 25% from Fp1 to C3. At the intersection is your **F3** cross mark + . Repeat for the opposition side, Fp2 to C4 (**F4** mark).
- Measure and mark half the distance or 25% from C3 to O1. At the intersection is your **P3** mark. Repeat for C4 to O2 (for **P4** mark).



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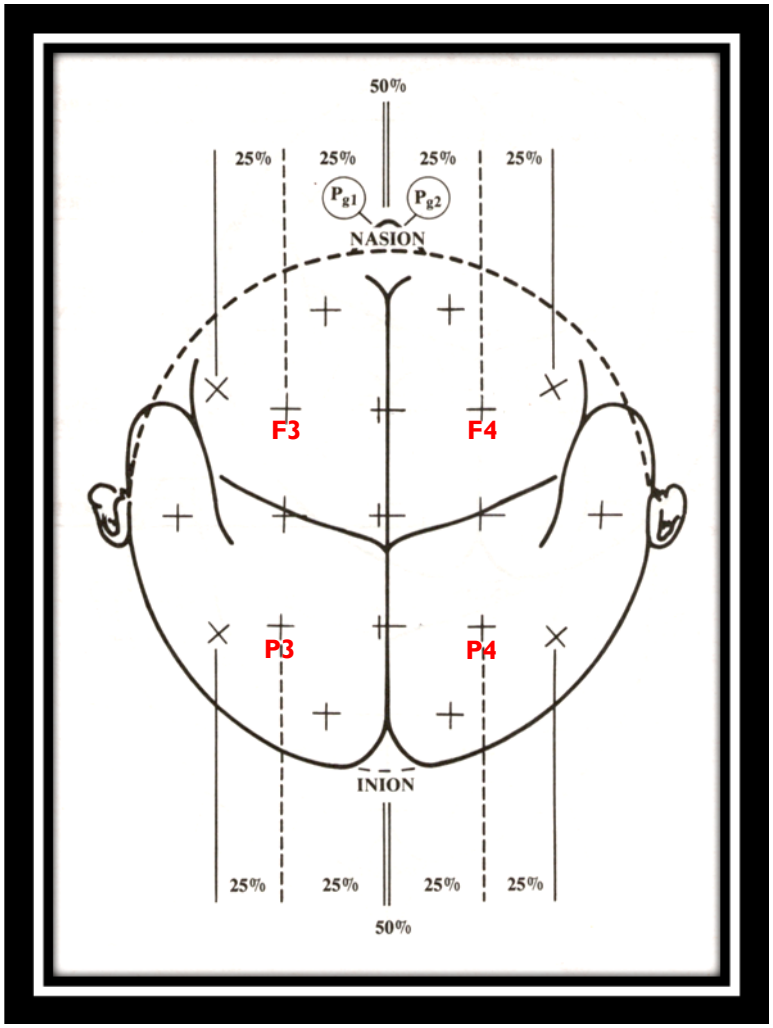
4.5 Step 5. Coronal

- Measure and mark 50% of the distance between the midline Fz to F8 and then repeat Fz to F7. These are your **F3** and **F4** marks, respectively.

- Measure and mark 50% the distance between mark PZ to T6 and then PZ to T5. These are your **P3** and **P4** marks.



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APPENDIX I

POD Training Record Form

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POD Title

Placement of Standard Scalp Electrodes Using The International Ten-Twenty System

SOP Code

Ownership	Document type	Area	SOP Number	Version
PC	POD	FA	003	v02

Training Record

Full Name	
Institution	
Contact (email or phone number)	

Signature

Sign here

Date