

The AASM Manual for the Scoring of Sleep and Associated Events

SCORING

Two to three pass method:

PASS #1:

- ▣ Staging at 30 second epochs (epoch by epoch approach)
- ▣ Score Spontaneous arousals at 30 second epochs
- ▣ Observe and note for any cardiac arrhythmias

PASS #2:

- ▣ Score respiratory events (either 90, 120, or 300 sec)

PASS #3:

- ▣ Score PLMS

Process for Staging

- ▣ Read between the lines
- ▣ Pattern Recognition
- ▣ Understanding Sleep Architecture
- ▣ Don't spend more than 1-2 seconds per epoch

EEG Derivations

- F₄-M₁
- C₄-M₁
- O₂-M₁

Backup electrodes : F₃-C₃, O₁, and M₂ to allow display - F₃-M₂, C₃-M₂ and O₁-M₂

Alternative Derivations: FZ-CZ, CZ-OZ, C4-M1

Backup electrodes: F_{pz}, C₃, O₁ and M₁ to allow for display - F_{pz} for F_z, C₃ for C_z or C₄, O₁ for O_z, and M₂ for M₁

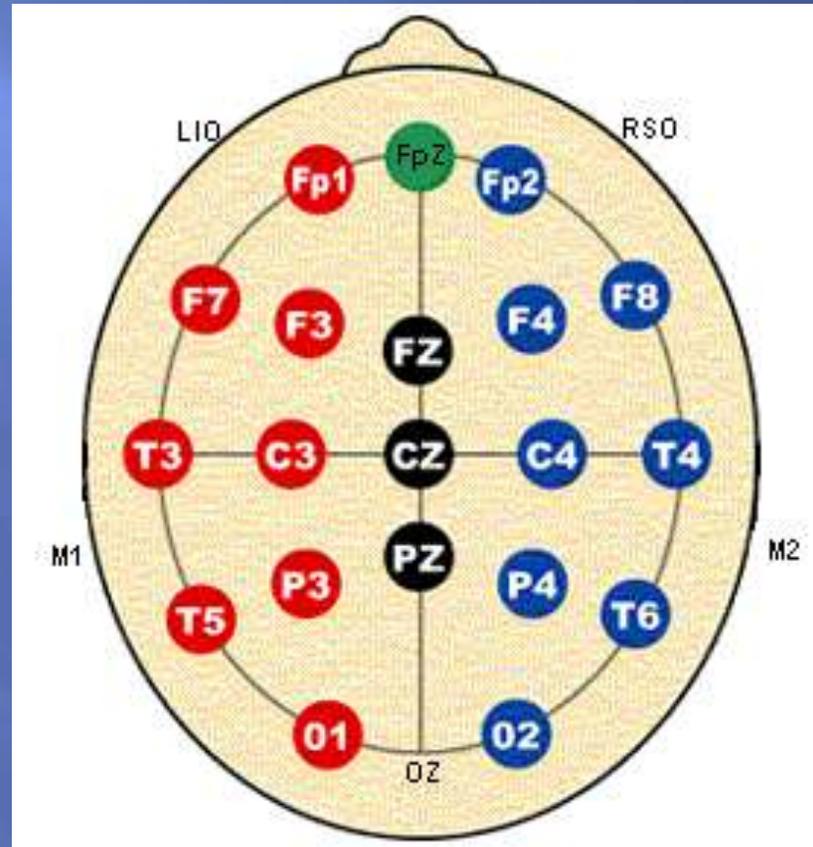
EEG Derivations

Recommended

F_4-M_1
 C_4-M_1
 O_2-M_1

Backup

F_3-M_2
 C_3-M_2
 O_1-M_2



Alternative

F_z-C_z
 C_z-O_z
 C_4-M_1

Backup

F_{pZ}	M_2	C_3	O_1
↓	↓	↓	↓
F_z	C_z/C_4	O_z	M_1

Rationale for Derivations

origin of characteristic sleep EEG components

Frontal-central region

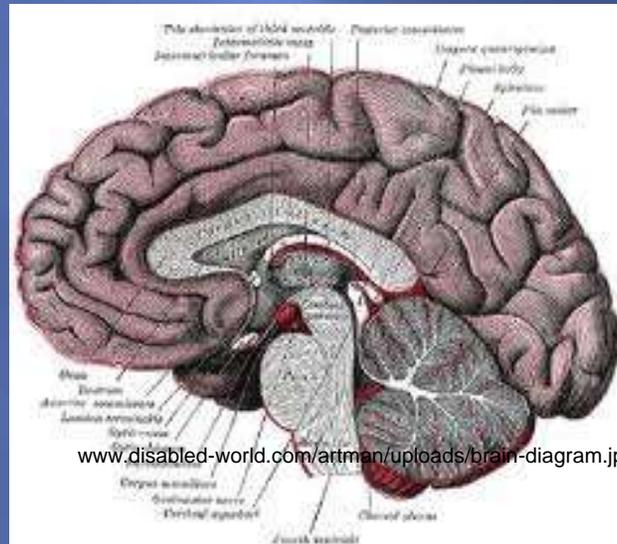
*Beta waves, interspersed throughout low-amplitude mixed-frequency activity; bursts with *benzodiazepine and barbiturate ingestion*

Central region

Spindles; Vertex Sharp Waves; Saw-tooth Waves;
↓ other theta-range activity

Frontal Lobe →

K-complexes and Delta waves



← **Occipital Lobe**

Alpha/PDR activity – now referred to as Posterior Dominant Rhythm PDR

*Can also result in excessive spindle activity

Rationale for EEG Derivations

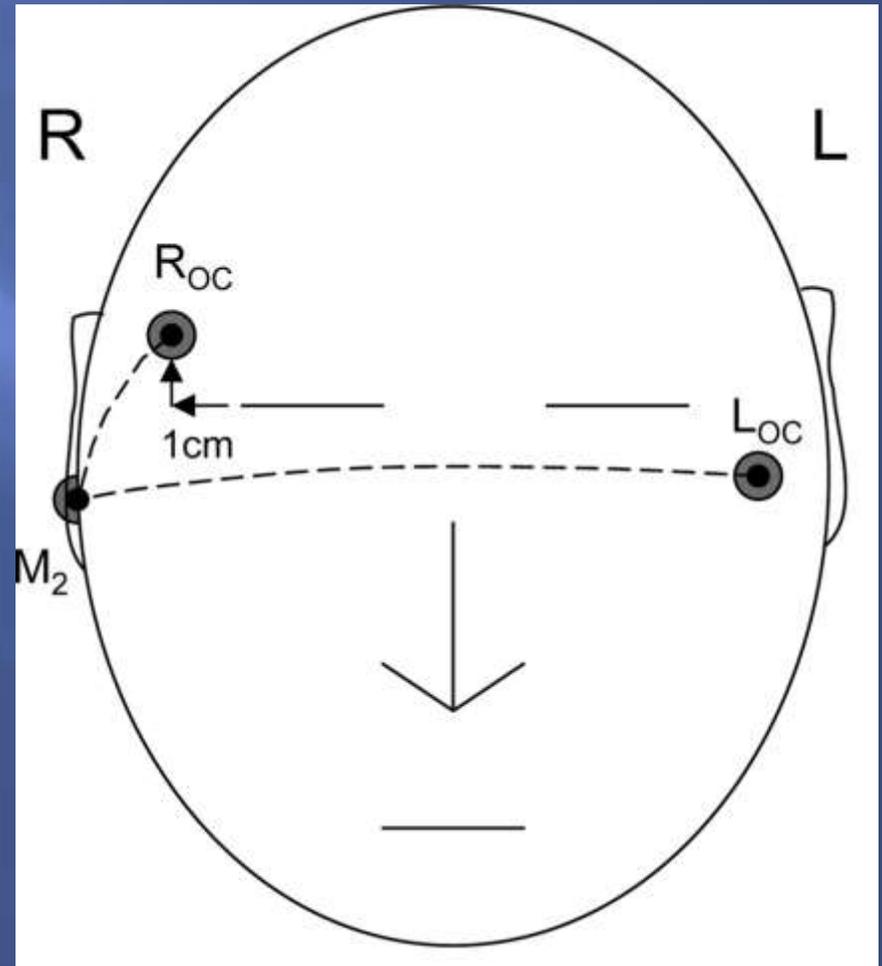
- Maximal amplitude displayed from the site of origin using recommended referential derivations, but mastoid placement can contain EMG and EKG artifact.
- Alternative bipolar derivations purportedly record LESS artifact from EMG and EKG, but will not display maximal amplitude from site of origin.

EOG Derivations

Recommended:

E1-M2 and E2-M2

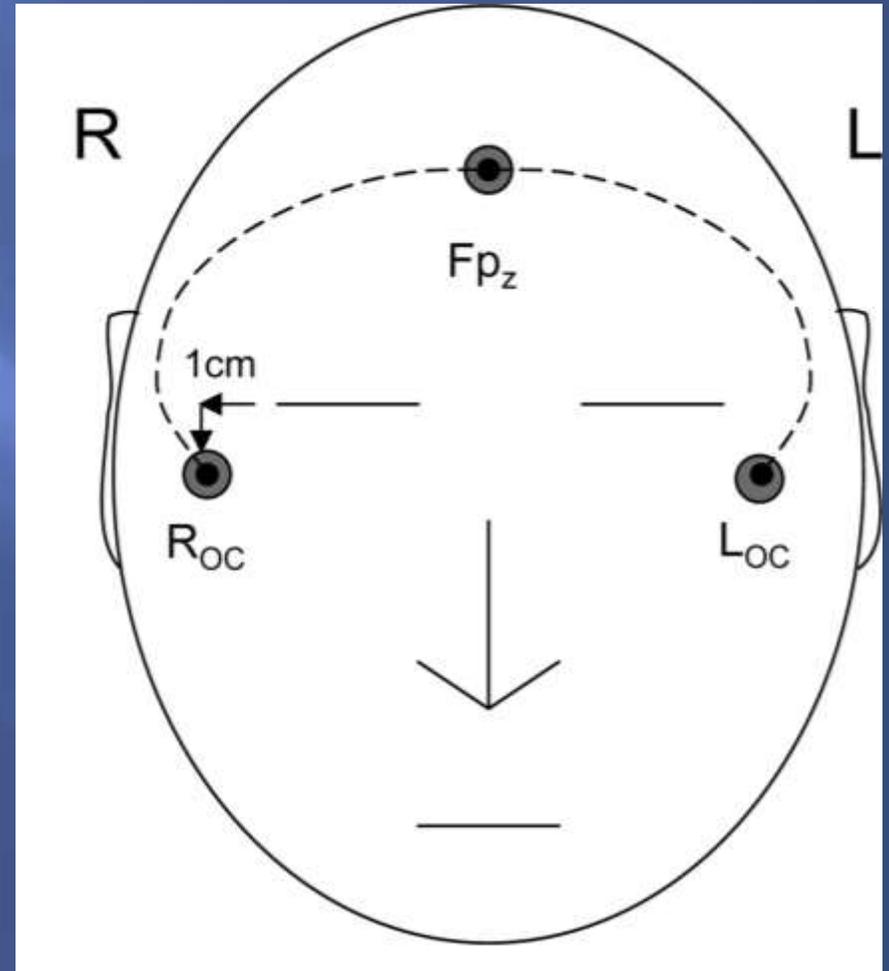
- E1 is placed **1 cm below** the left outer canthus – not lateral
- E2 is placed **1 cm above** the right outer canthus – not lateral



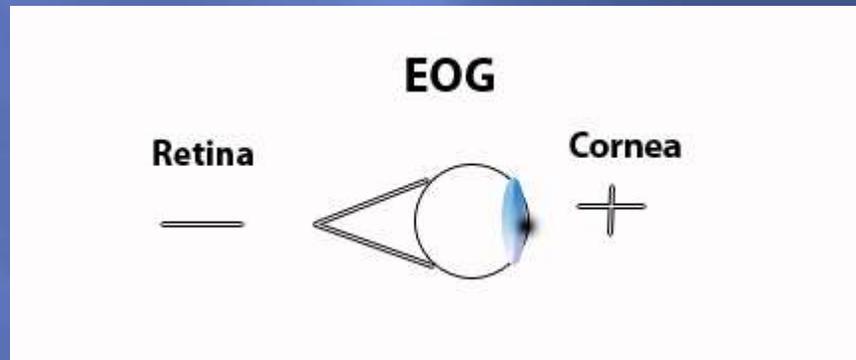
EOG Derivations

Alternative: E1-Fpz
and E2-Fpz

- E1 placed 1 cm below and 1 cm lateral to the left outer canthus
- E2 placed 1 cm below and 1 cm lateral to the right outer canthus



Remember...



Differences in EOG Placement

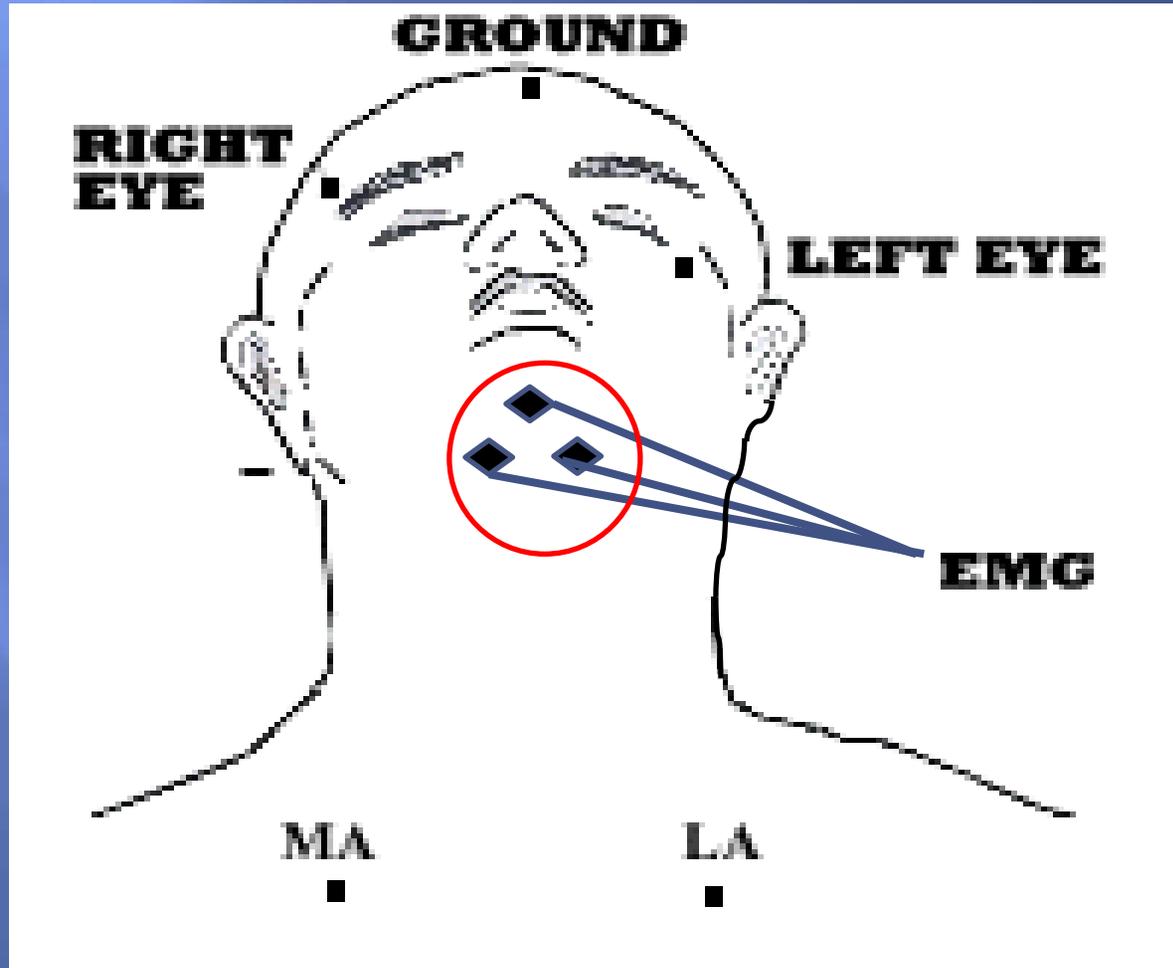
- **Recommended derivation** - eye movement direction, oblique movements, and low amplitude signals are not displayed; artifact more readily seen.
- **Alternative derivation** - vertical movements seen as **in-phase deflections**; horizontal movements as **out-of-phase deflections**; oblique movements are recorded.

Chin EMG Electrode Placement

3 recording electrodes recommended

- ▣ One midline electrode - 1 cm above the inferior edge of the mandible
- ▣ Two electrodes placed 2 cm below the inferior edge of the mandible; one 2 cm right and the other 2 cm left of the midline.

Midline electrode referenced to one of the two lower electrodes



Epoch Scoring

- 30-second epoch scoring with a stage assigned to each epoch
- If two or more sleep stages occur on one epoch, assign the score to the stage comprising the majority of the epoch

Sleep Stage Terminology

The stages of sleep are defined as:

- Stage W (Wakefulness)
- Stage N1 (NREM 1)
- Stage N2 (NREM 2)
- Stage N3 (NREM 3)
- Stage R (REM)

Stage W

Represents alert wakefulness to drowsiness

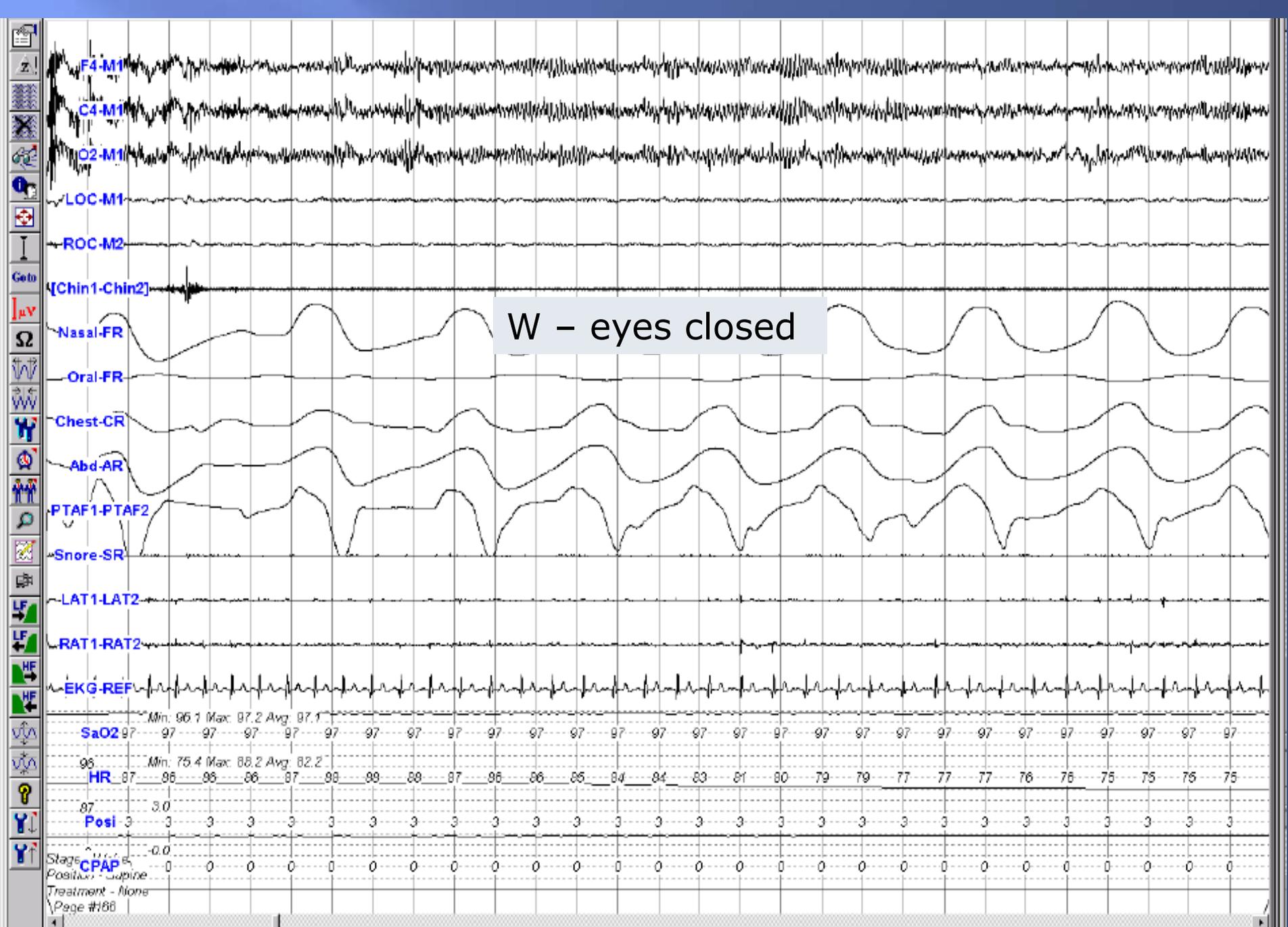
Comprised of more than 50% Alpha/PDR rhythm (8-13 Hz—typically 9-11 Hz in adults)

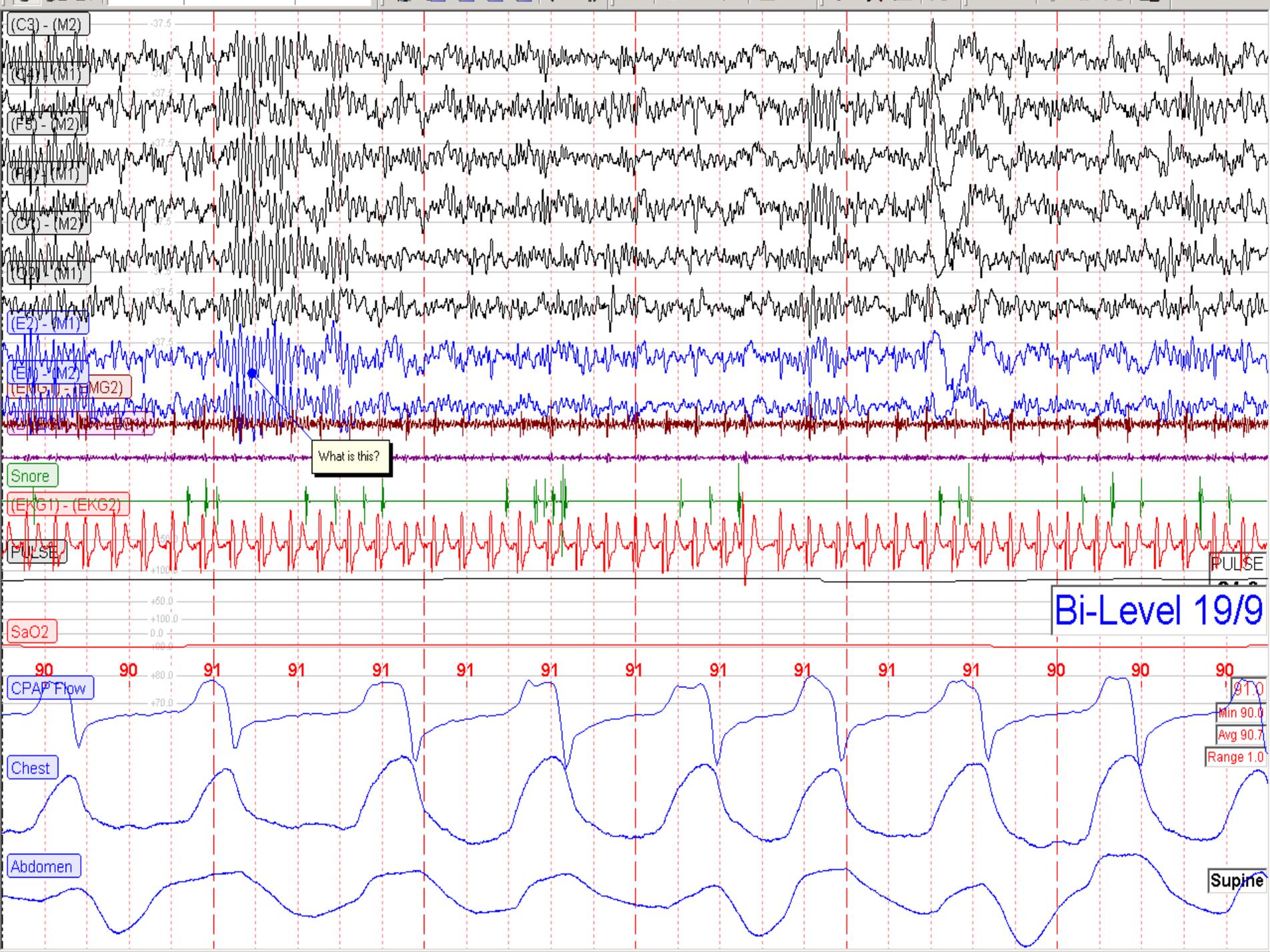
Alpha/PDR rhythm is maximal over occipital region during eye closure

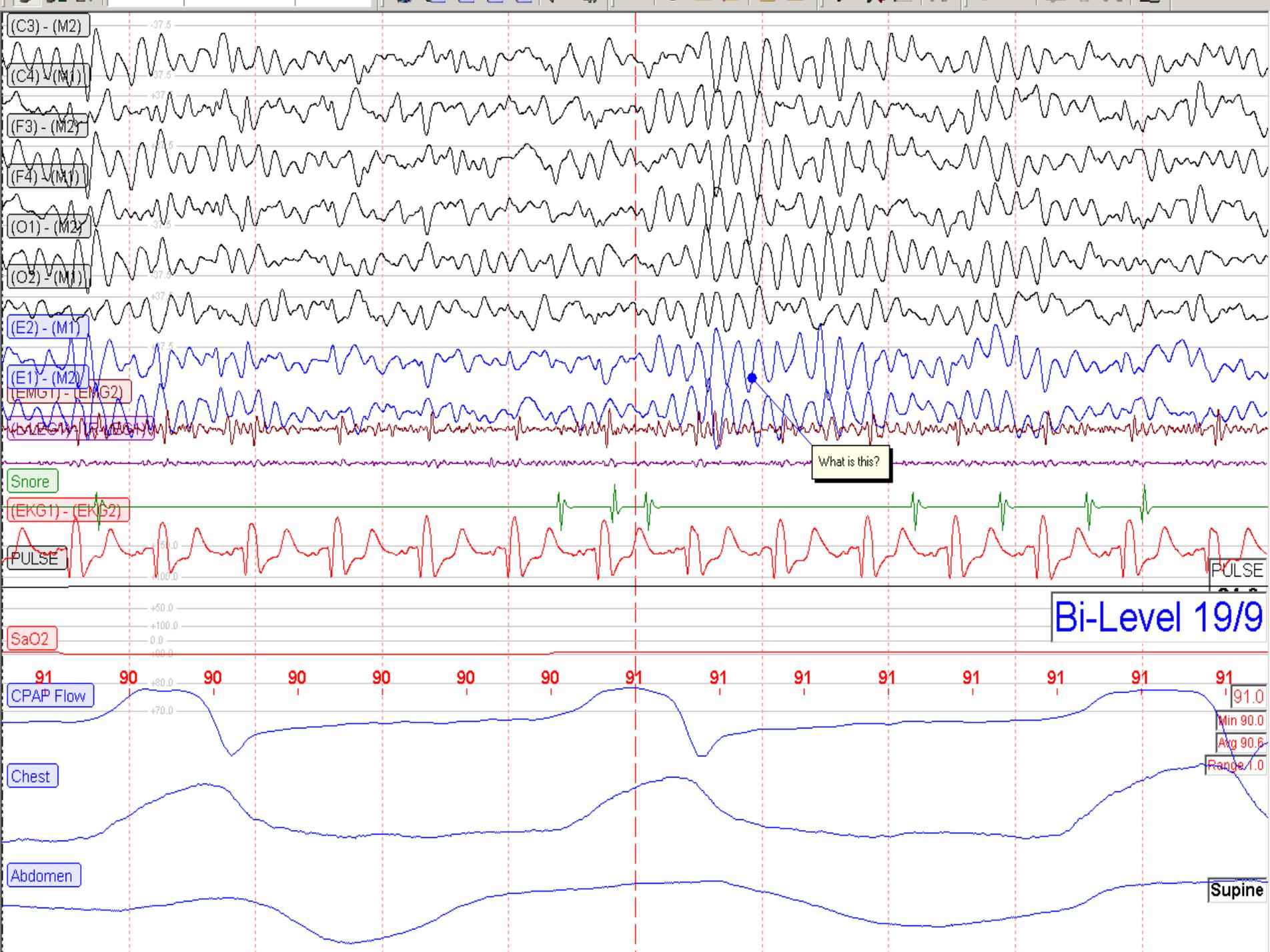
Alpha/PDR rhythm is attenuated when eyes are opened and replaced by a low-amplitude, mixed-frequency EEG pattern

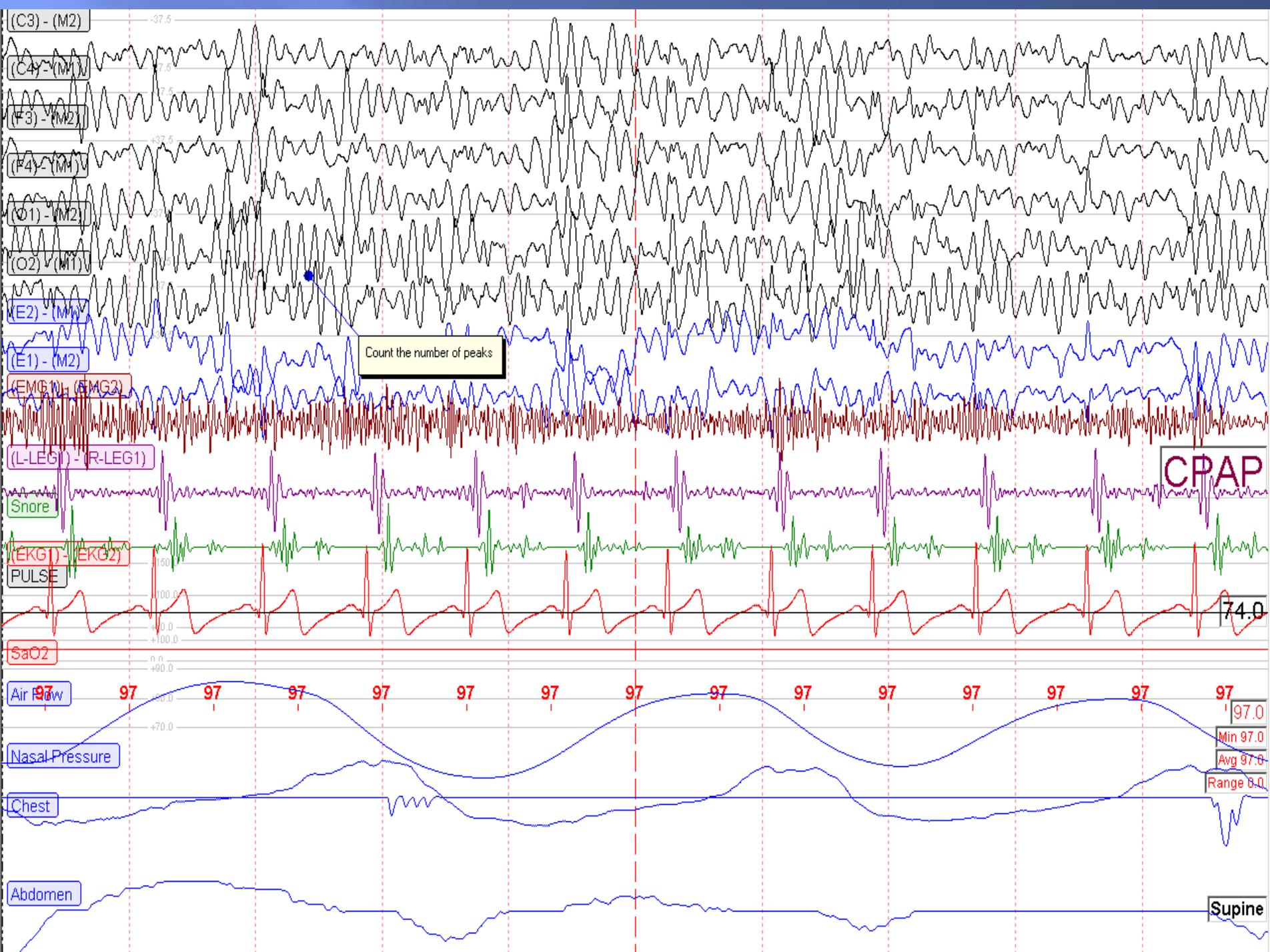
Stage W - Non-Alpha/PDR Producers

- Additional parameters to assist in scoring:
 - **Eye Blinks** – conjugate vertical movements in the 0.5-2 Hz range; seen when eyes are opened or closed
 - **Reading eye movements** – trains of conjugate eye movements; slow phase followed by a rapid phase in opposite direction
 - **Rapid eye movements** – seen in stage W when a subject scans the environment; EMG tone is normal or high; eye movements are conjugate, irregular, and sharply peaked









Stage N1 (5%)

EEG: Theta waves 4-7 cps

Also known as Low Voltage Mixed Frequency (LVMF) waves

Vertex Sharp Waves: Monophasic surface-negative sharp waves;
followed by a positive component lasting < 0.5 sec duration

Seen maximally over the central regions

EOG: Slow Eye Movements may occur
(primarily from wake to N1)

EMG: Generally elevated but a little lower
than Wake

Stage N1

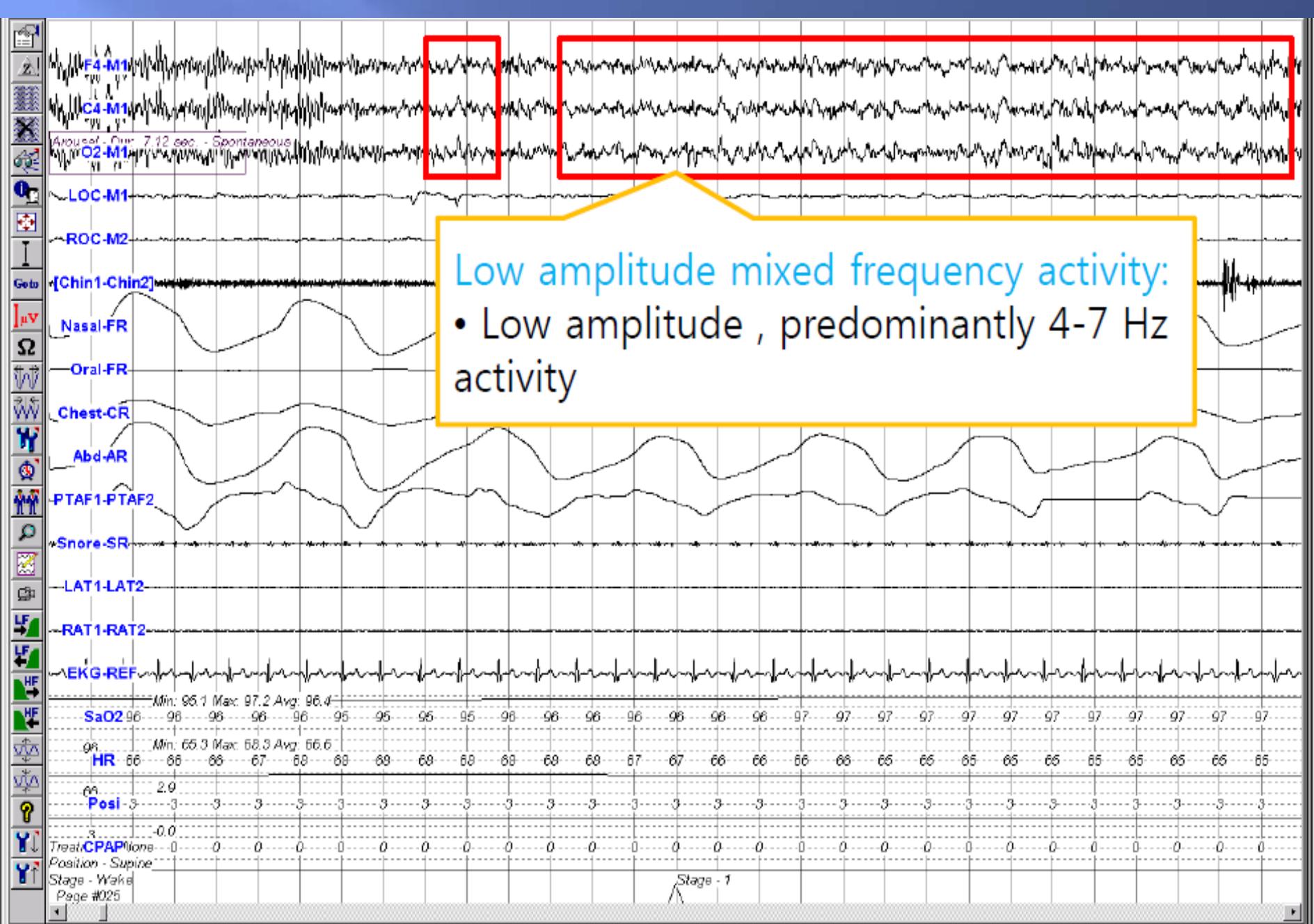
In most subjects, **Stage N1** indicates **sleep onset** (the start of the first epoch that is scored as any stage other than Stage W)

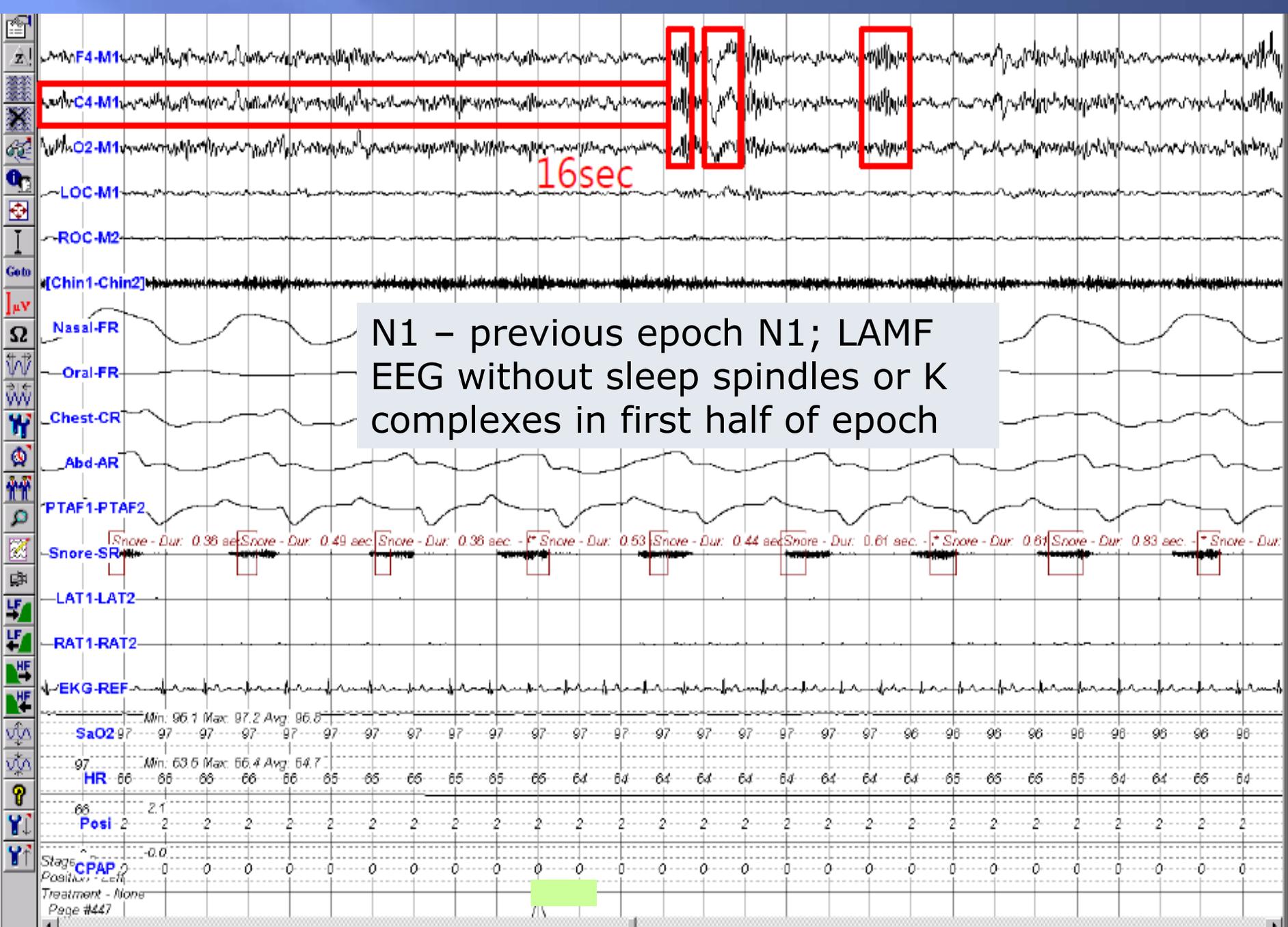
- In **Alpha/PDR producers**, Stage N1 is scored when Alpha/PDR is replaced and **> 50%** of the epoch contains LAMF activity

Continue to score an epoch with a LAMF background as N1, *even if there is a*

K complex if it is associated with an arousal, and there are no spindles or K

complexes not associated with an arousal





Stage N1

In non-Alpha/PDR producers, score Stage N1 when any of the following appear:

- 4-7 Hz activity with slowing of background by ≥ 1 Hz from those of Stage W
 - Vertex sharp waves
 - Slow eye movements
- *Chin EMG is variable but usually lower than in Stage W; no impact on scoring
- *Vertex sharp waves and slow eye movements not required to score N1
- *Slow eye movements may appear prior to Alpha/PDR attenuation in Alpha/PDR producers; earlier scoring of sleep onset in non-Alpha/PDR producing subjects may be a result

Stage N2 (50%)

EEG: Theta waves (4-7 cps) interspersed with K-complexes and/or sleep spindles (13-16 cps).

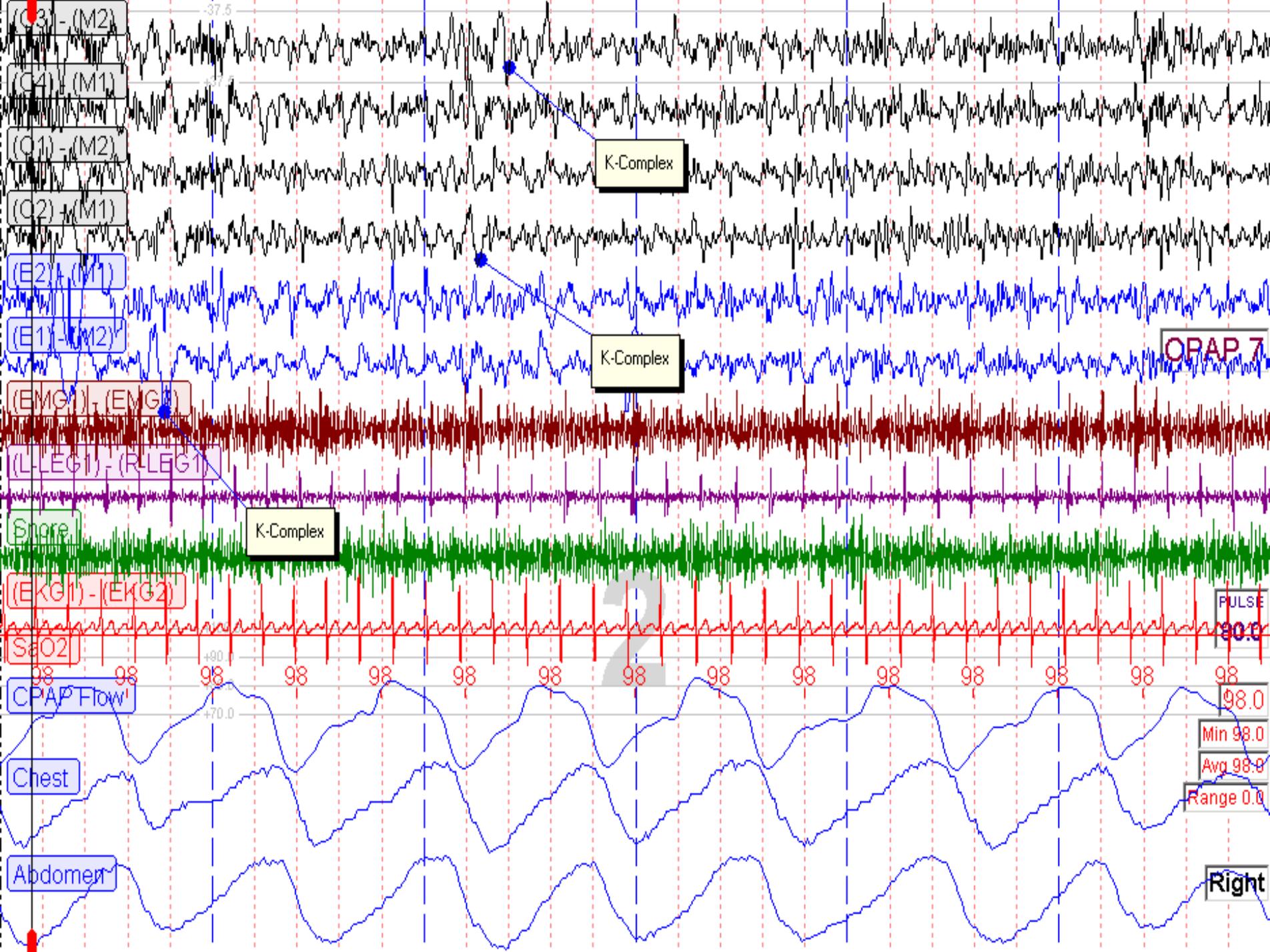
K-Complex: a well-defined negative sharp wave, followed immediately by a positive component standing out from the background EEG; total duration ≥ 0.5 seconds; usually maximal in amplitude using frontal derivations. *For an arousal to be associated it must commence ≤ 1 s after termination of the K complex*

Stage N2

Sleep spindles: train of distinct waves with frequency 11-16 Hz (most commonly 12-14 Hz) with a duration ≥ 0.5 seconds, usually maximal in amplitude using central derivations.

EOG: Same activity as EEG

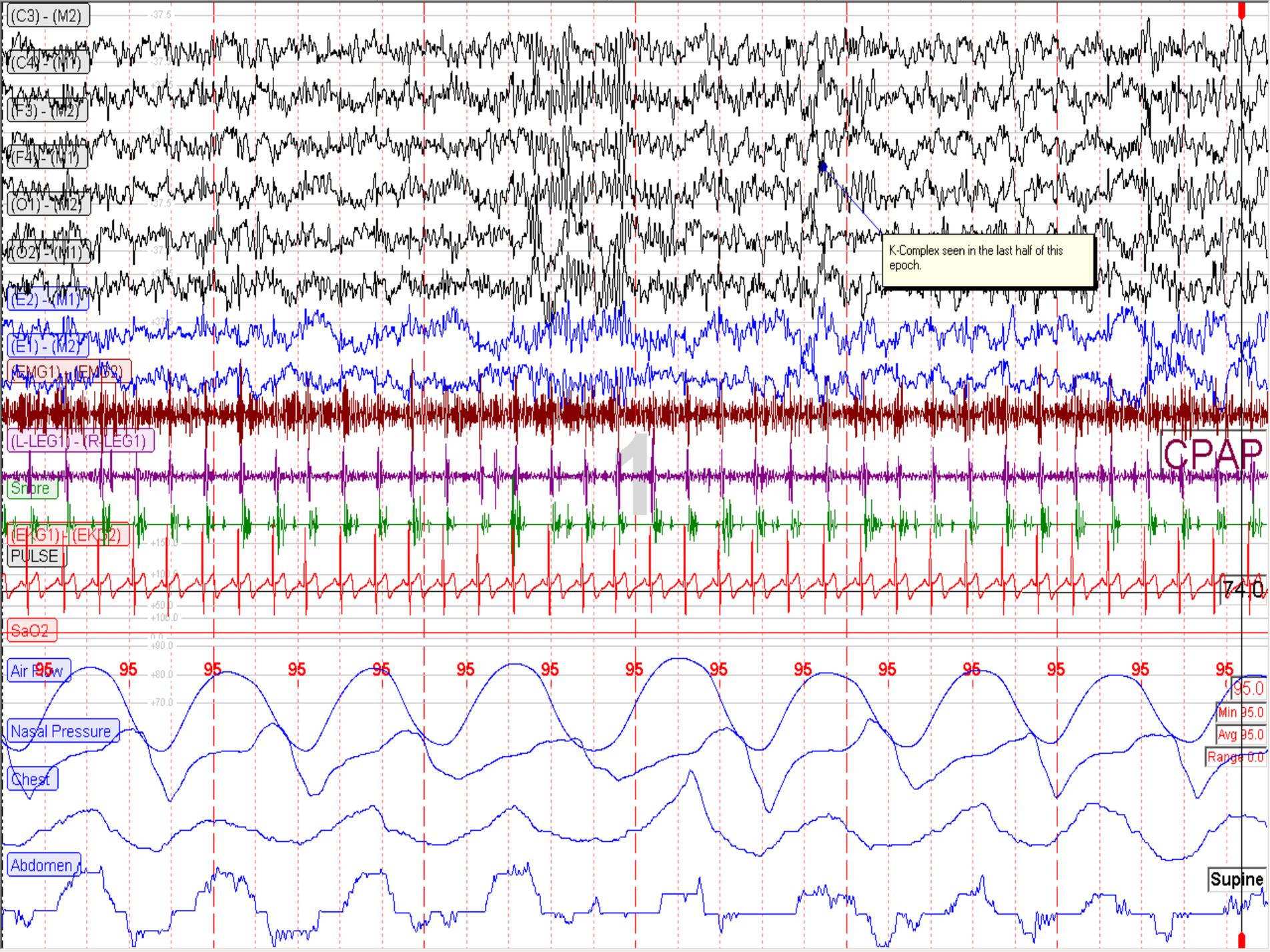
EMG: Relatively elevated but a little lower than that of Wake.

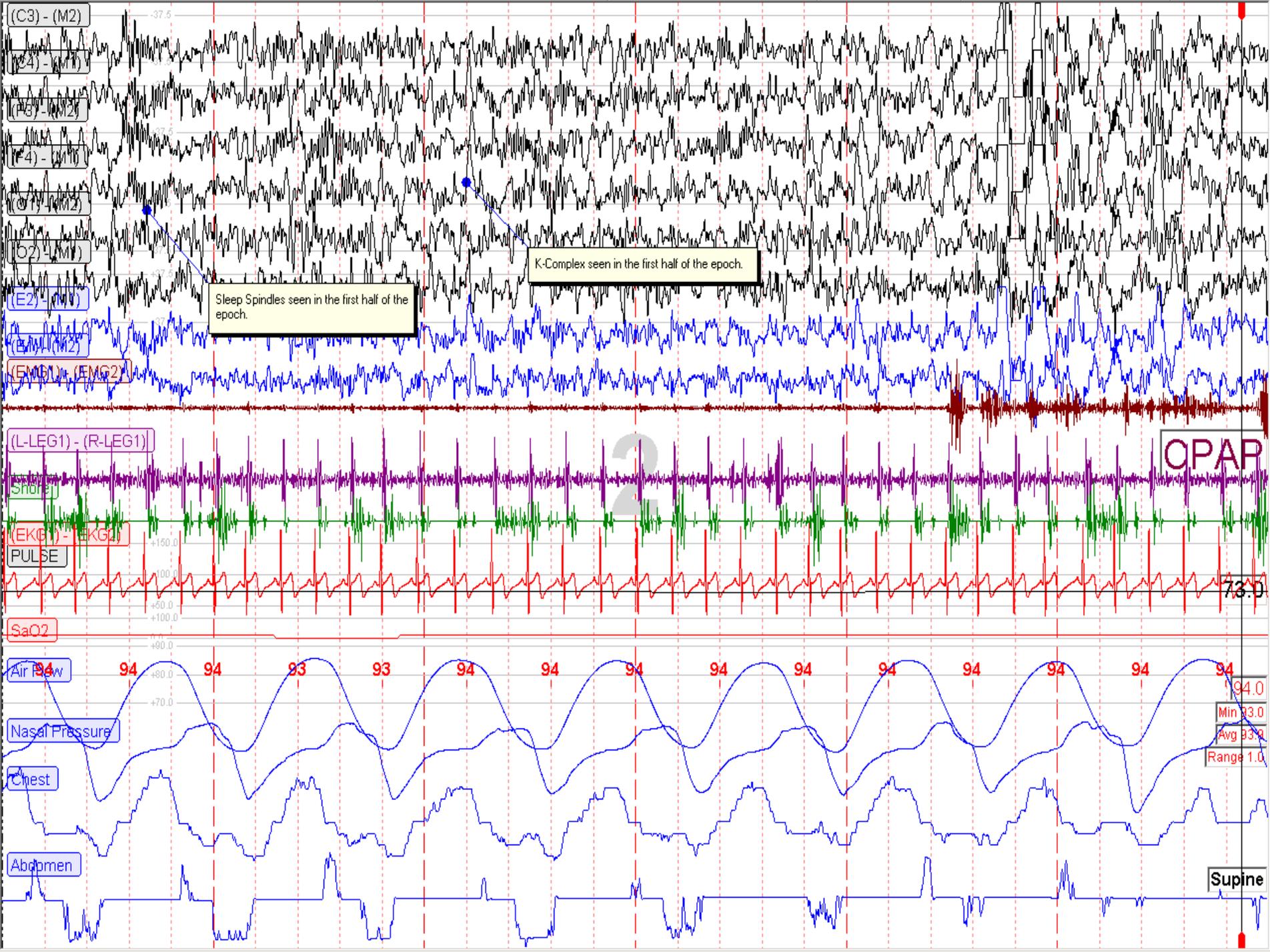


Rules for Stage N2 Sleep

Begin scoring stage N2 if one or both of the following occur ***during the first half of that epoch or the last half of the previous epoch:***

- a. One or more K-complexes unassociated arousals
- b. One or more trains of sleep spindles





Rules for Stage N2 Sleep

Continue to score epochs with low amplitude, mixed frequency EEG activity without K-complexes or sleep spindles as Stage N2 if they are preceded by:

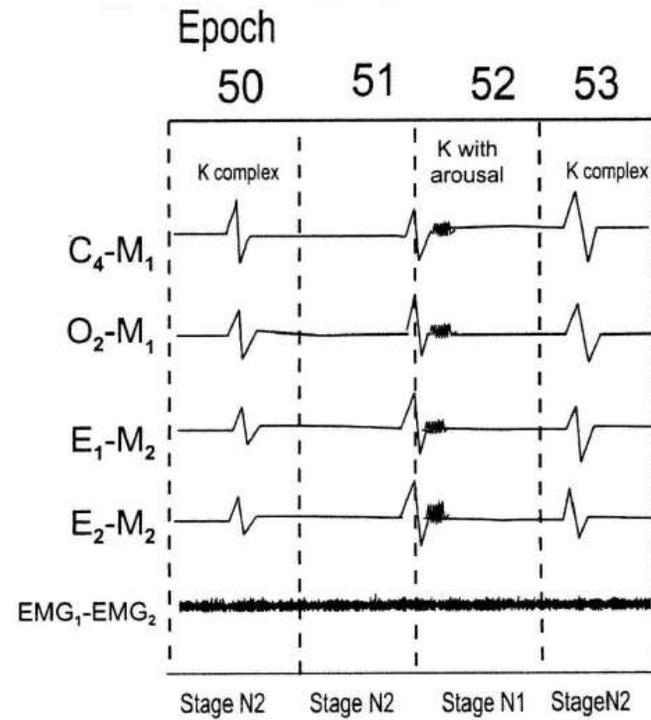
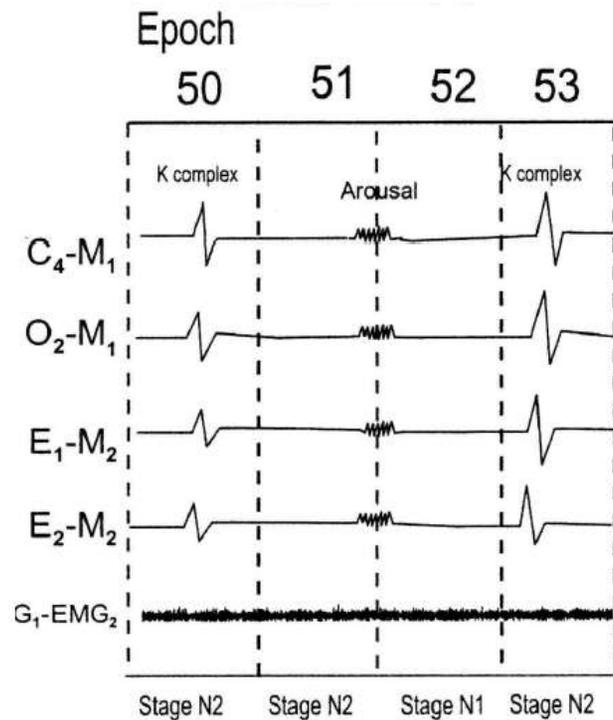
- a) K-complexes unassociated with arousals or
- b) Sleep spindles

Ending Stage N2

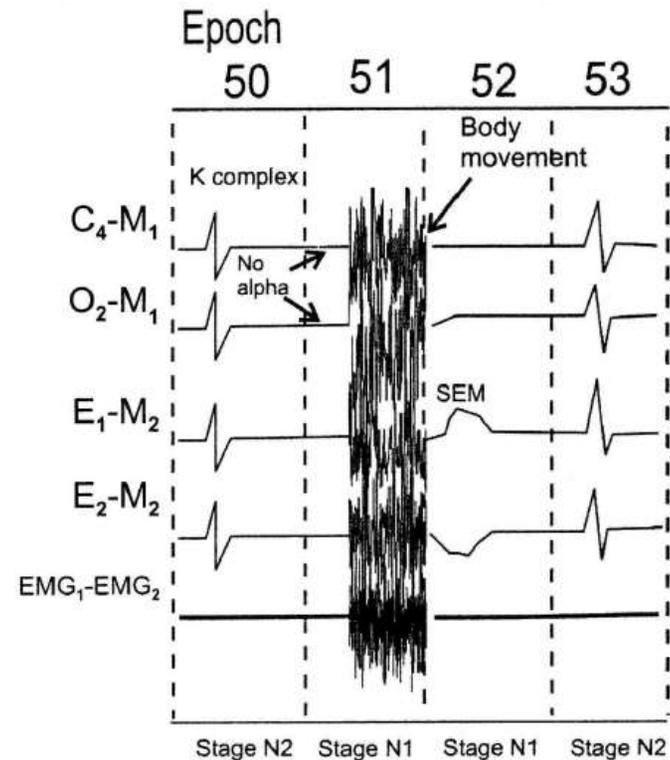
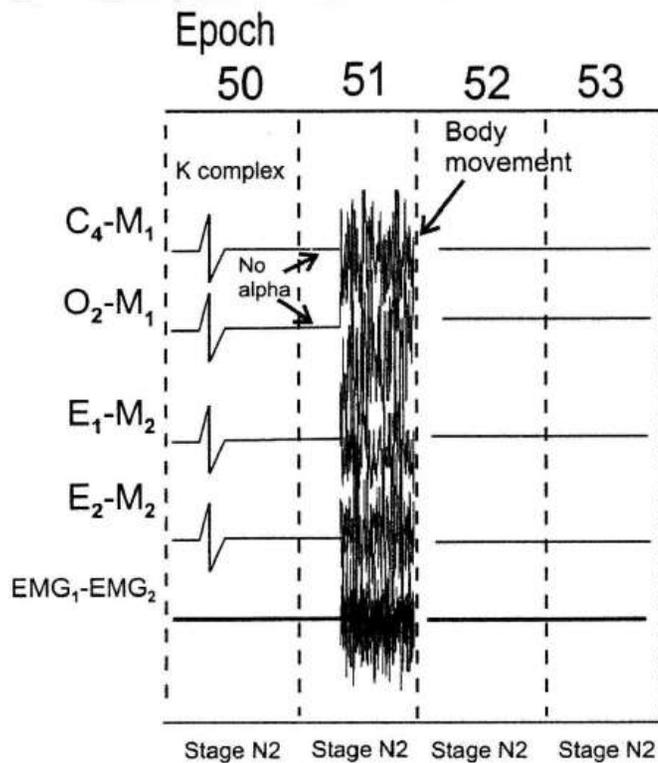
End stage N2 when there is a/an:

- **Stage Transition** to W, N3, or REM
- **EEG Arousal** - results in a transition to N1 or W unless N2 criteria are met
- If a **major body movement** occurs followed by SEMs and low-amplitude, mixed-frequency EEG without non-arousal associated K complexes or sleep spindles
 - score the epoch following the MBM as **N1 if SEMs**
 - if **no eye movements**, score as **N2**

Ending Stage N2



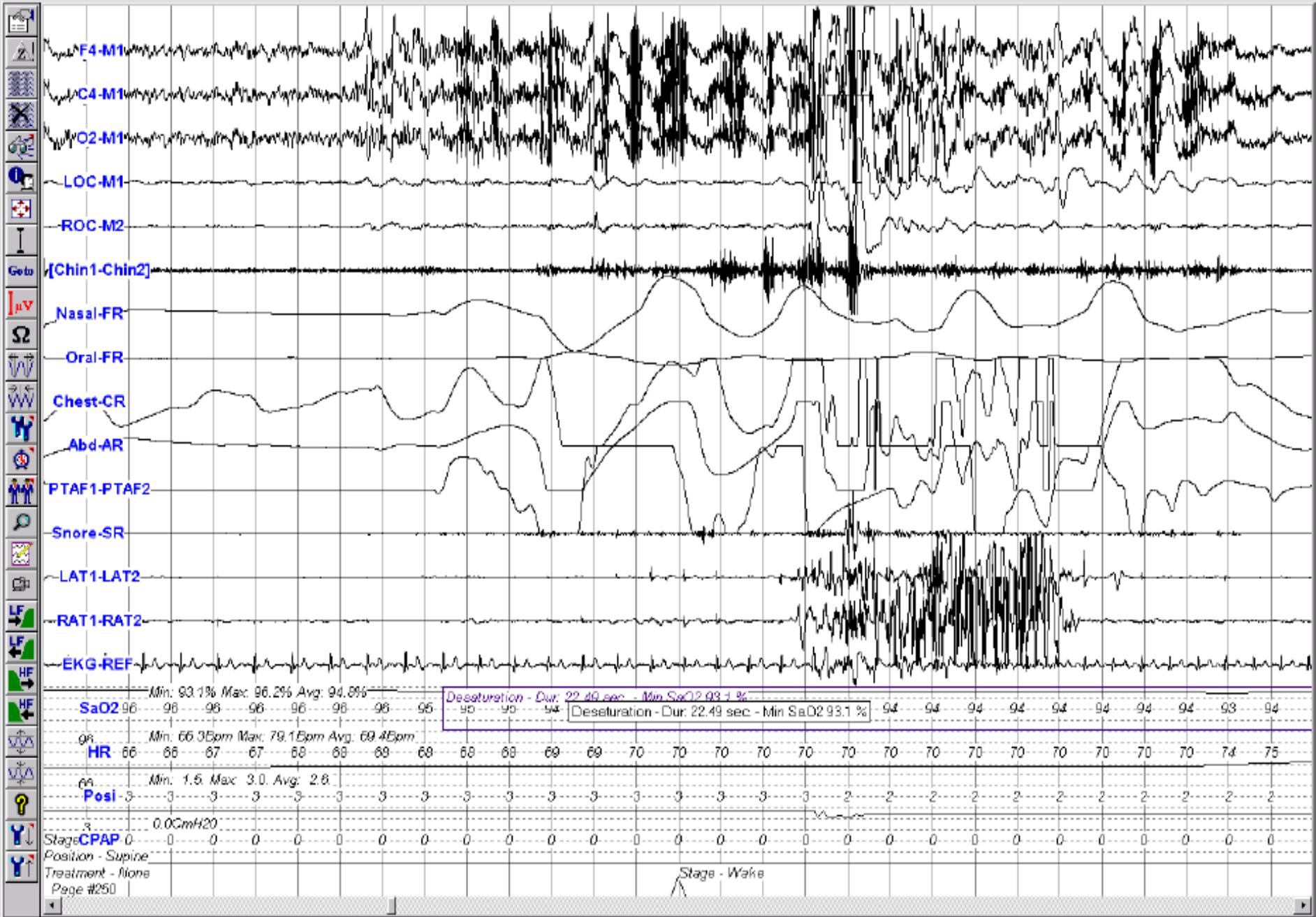
N2 and Major Body Movements



Major Body Movement

A **Major Body Movement** is scored when muscle artifact or movement artifact obscure more than half of the epoch

- If Alpha/PDR is present on the MBM epoch (even <15 seconds), score it as **Stage W**
- If Stage W precedes or follows the MBM epoch, score it as **Stage W**
- If no Alpha/PDR is present, score the MBM epoch the same stage as the epoch that follows it



Stage N3 (20%)

EEG: 3 criteria needed:

1. 0.5 – 3 cps
2. Amplitude must be at least 75 μ V from peak-to-peak
3. Occupying 20% of the epoch (cumulative)
 - ▣ Sleep spindles may be present No change in Definitions or Rules.
 - ▣ One note added explaining that K complexes are considered to be slow waves if they meet the definition of slow wave activity.

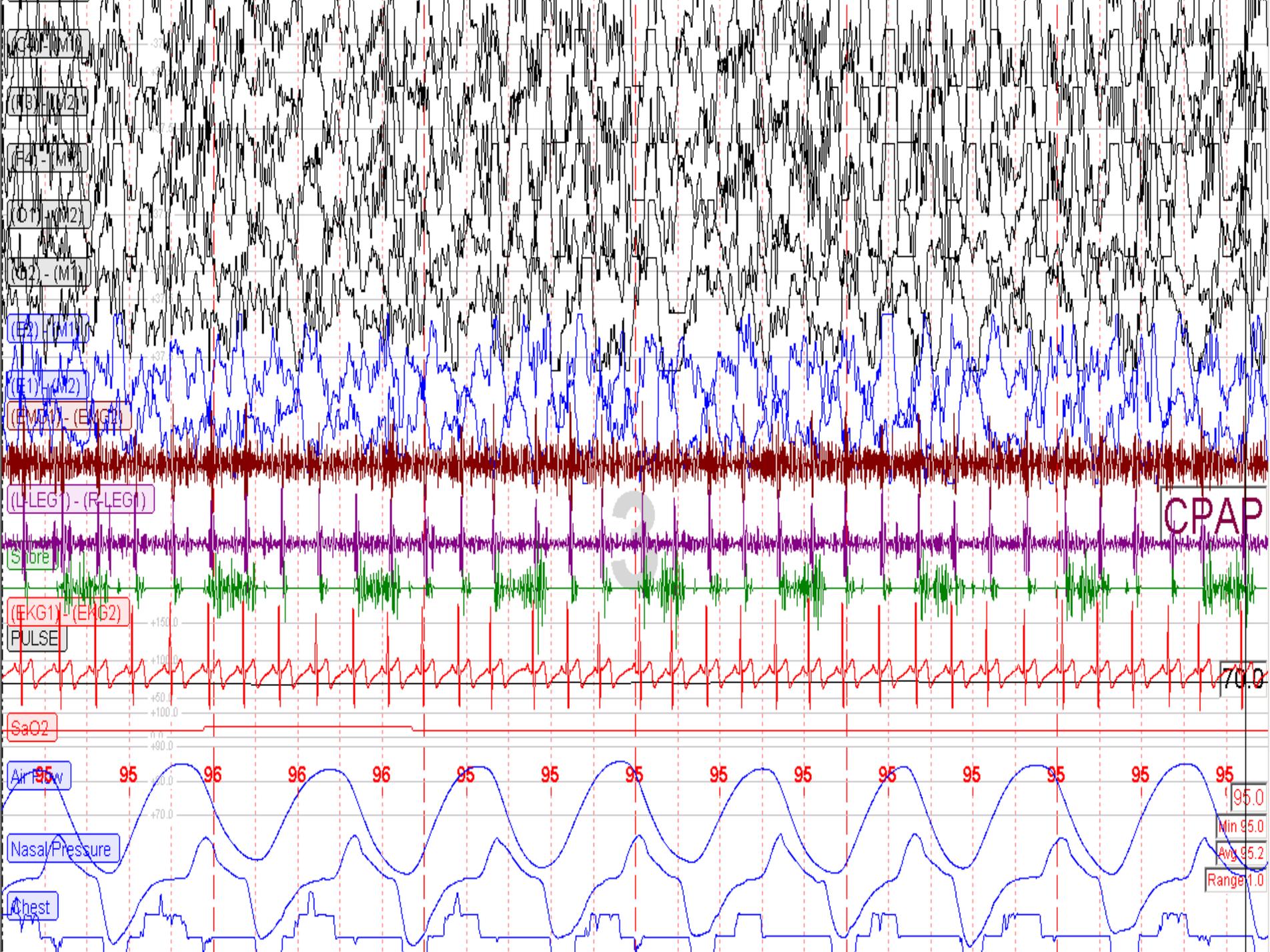
EOG: Same activity as EEG

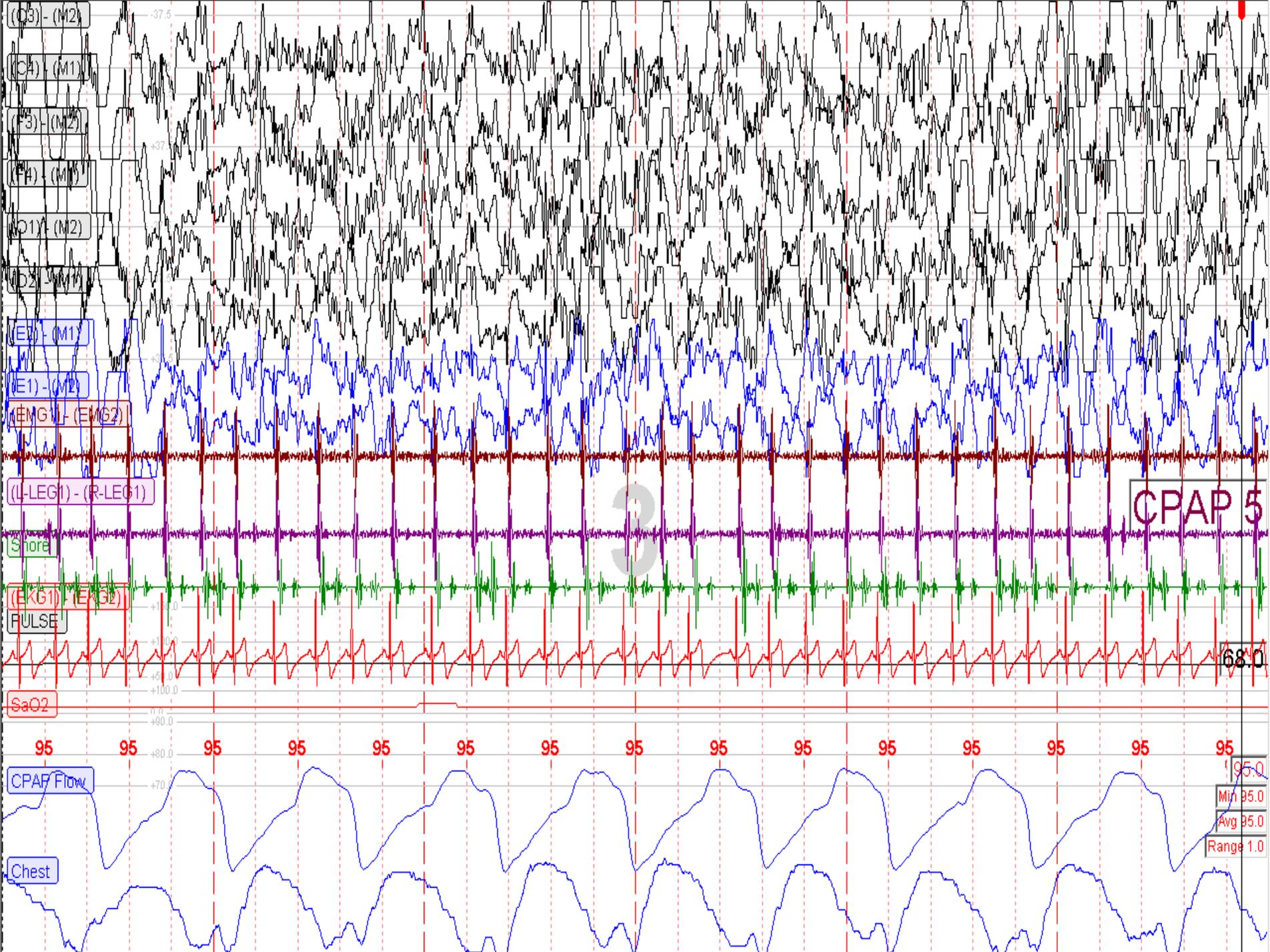
EMG: Variable amplitude; often lower than in Stage N2 and sometimes as low as in Stage R.

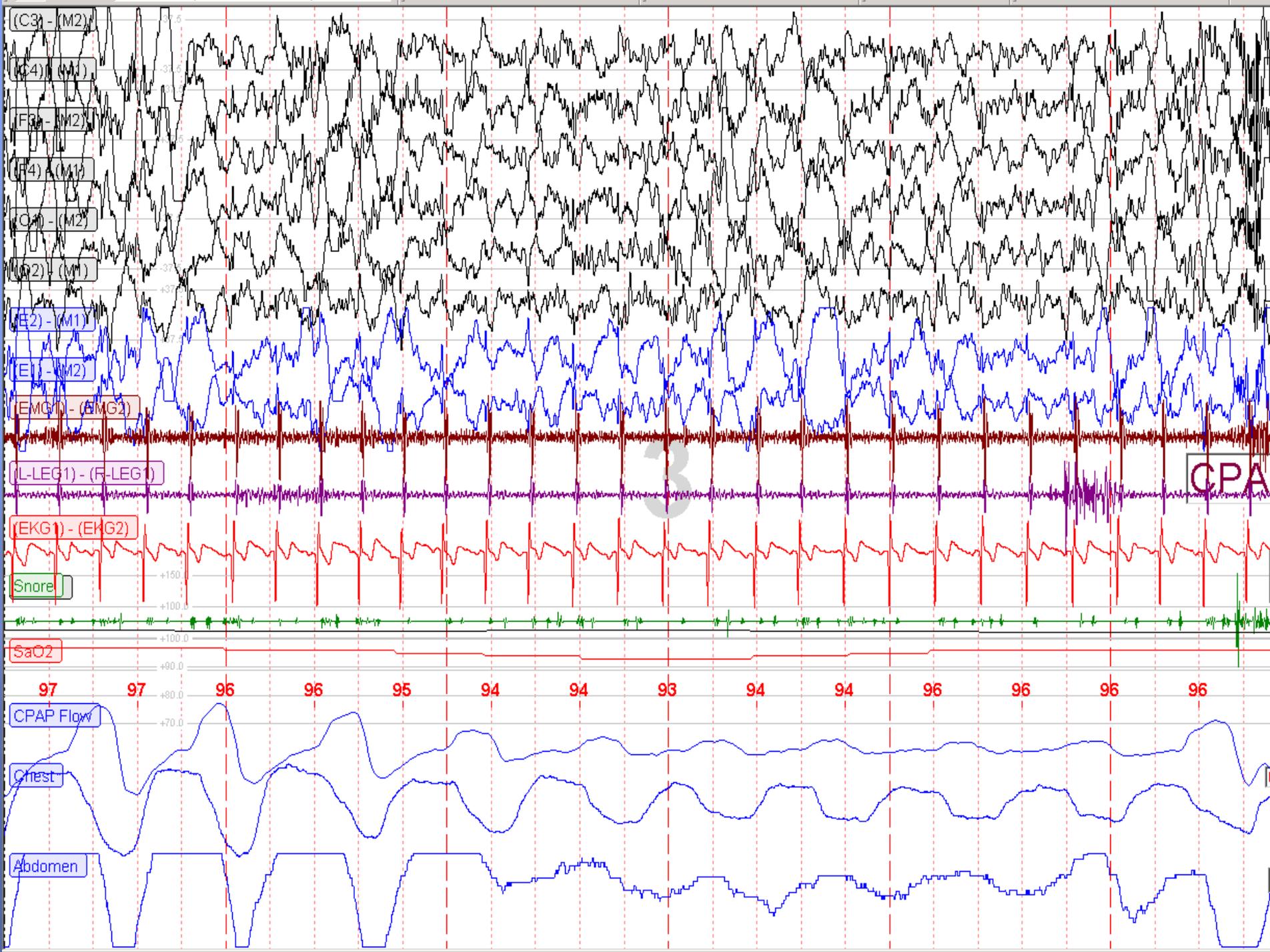
Stage N3

The 75 μV criteria applies to all ages:

- Slow wave sleep amplitude decreases with age but the decrease is in parallel to frequencies of other EEG waveforms
- Slow wave activity measuring $>75 \mu\text{V}$ can be detected at any age and should be scored from F_4-M_1 or F_Z-C_Z (frontal derivations)
- Slow-wave amplitude progressively increases as subject age decreases







Stage REM

- ▣ Rapid eye movements are conjugate, irregular, and sharply peaked with an initial deflection < 500 ms in duration
- ▣ Chin EMG tone is no higher than in any other sleep stage and usually at the lowest level of the entire recording
- ▣ Sawtooth waves are sharply contoured or triangular, often serrated, 2-6 Hz waves which often precede bursts of REMs. Maximal over the central regions

Stage R (20-25%)

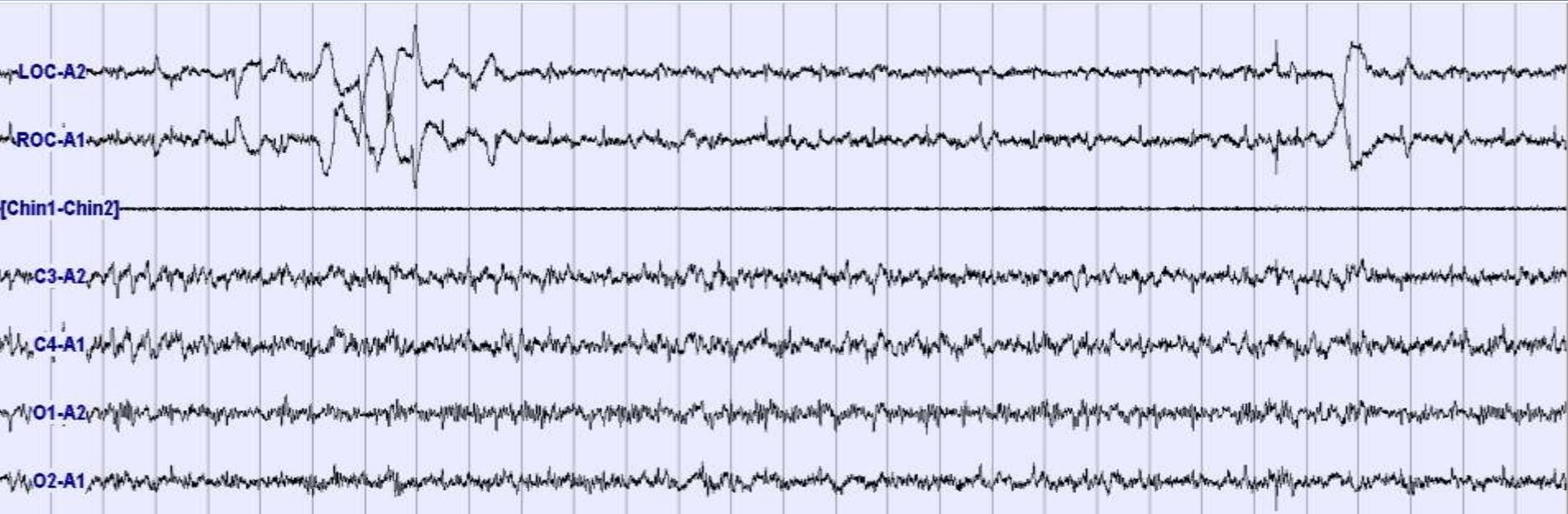
EEG:

- ▣ Theta waves (4-7 cps)
- ▣ Alpha waves present but 1-2 cps slower than that of Wake
- ▣ Sawtooth waves (sharply contoured, triangular; often serrated (2-6 Hz) preceding bursts of rapid eye movements.

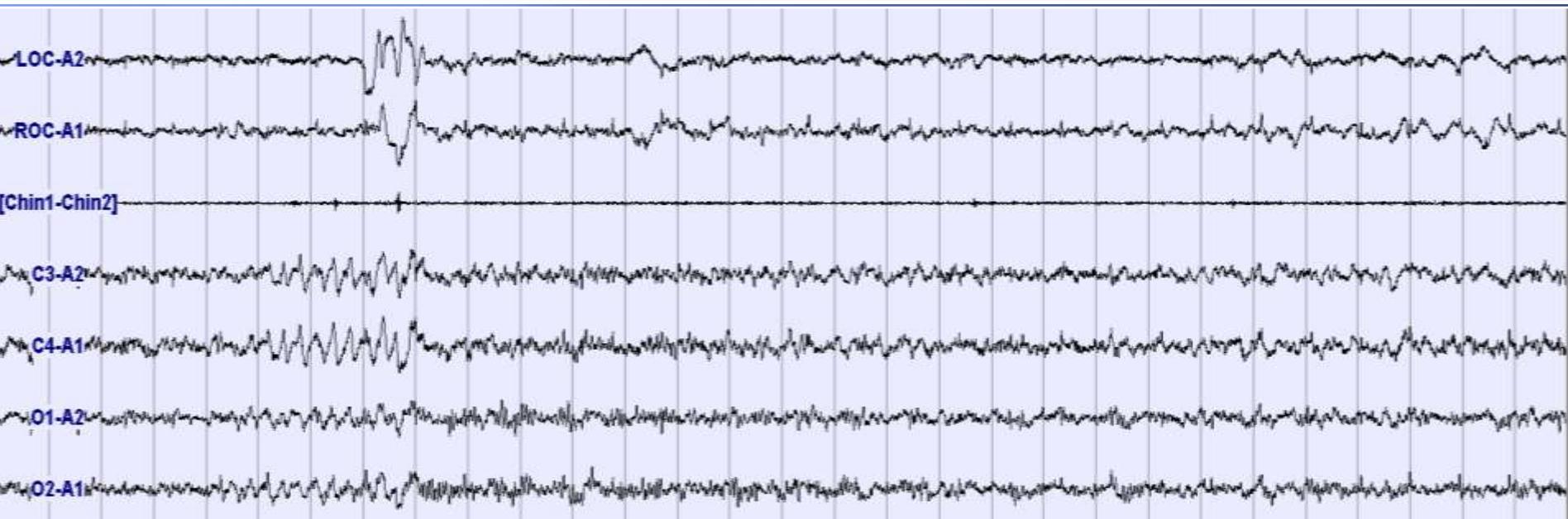
EOG: Rapid Eye Movements may be present

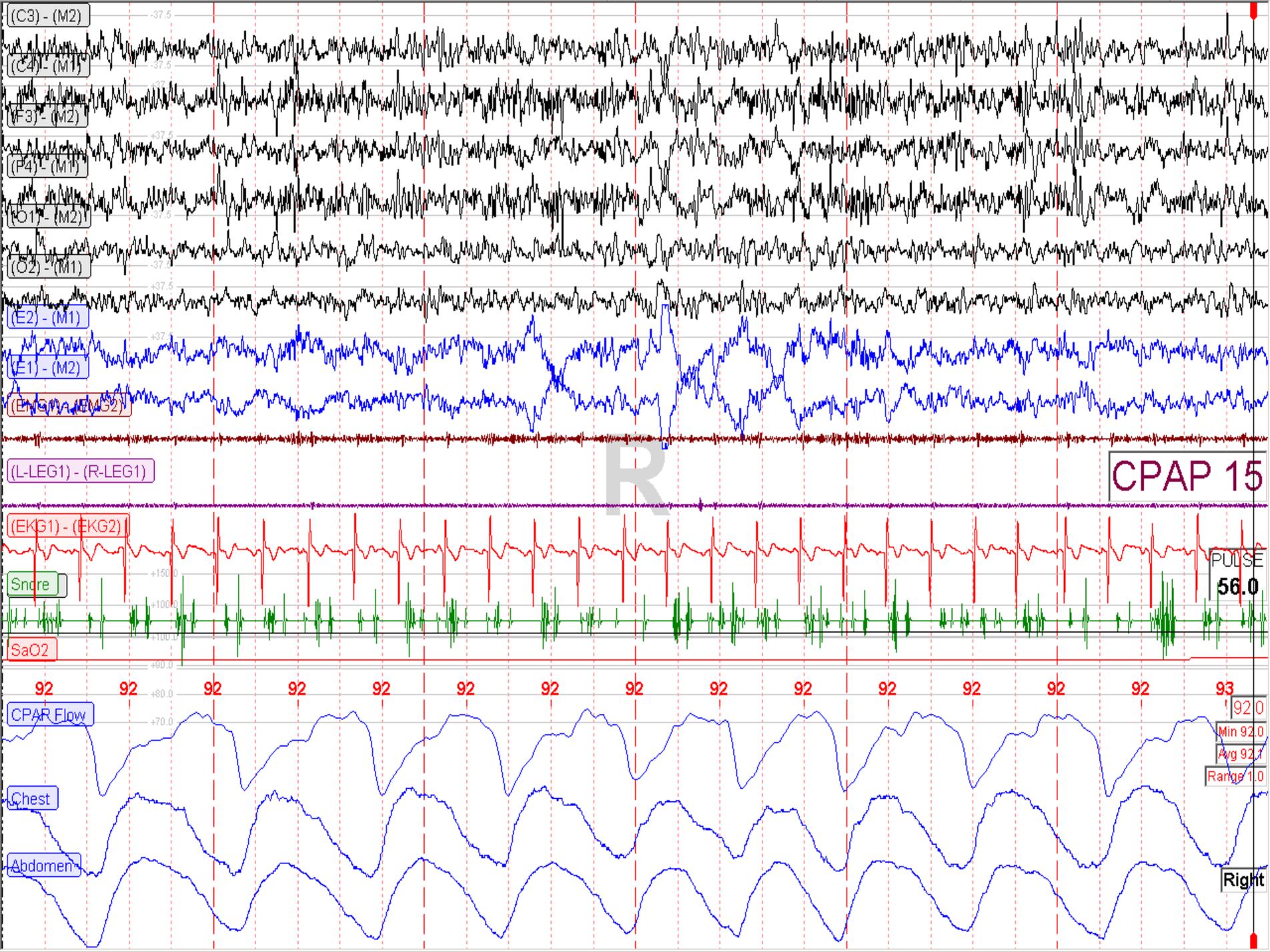
EMG: Significantly reduced compared to Non-REM sleep.

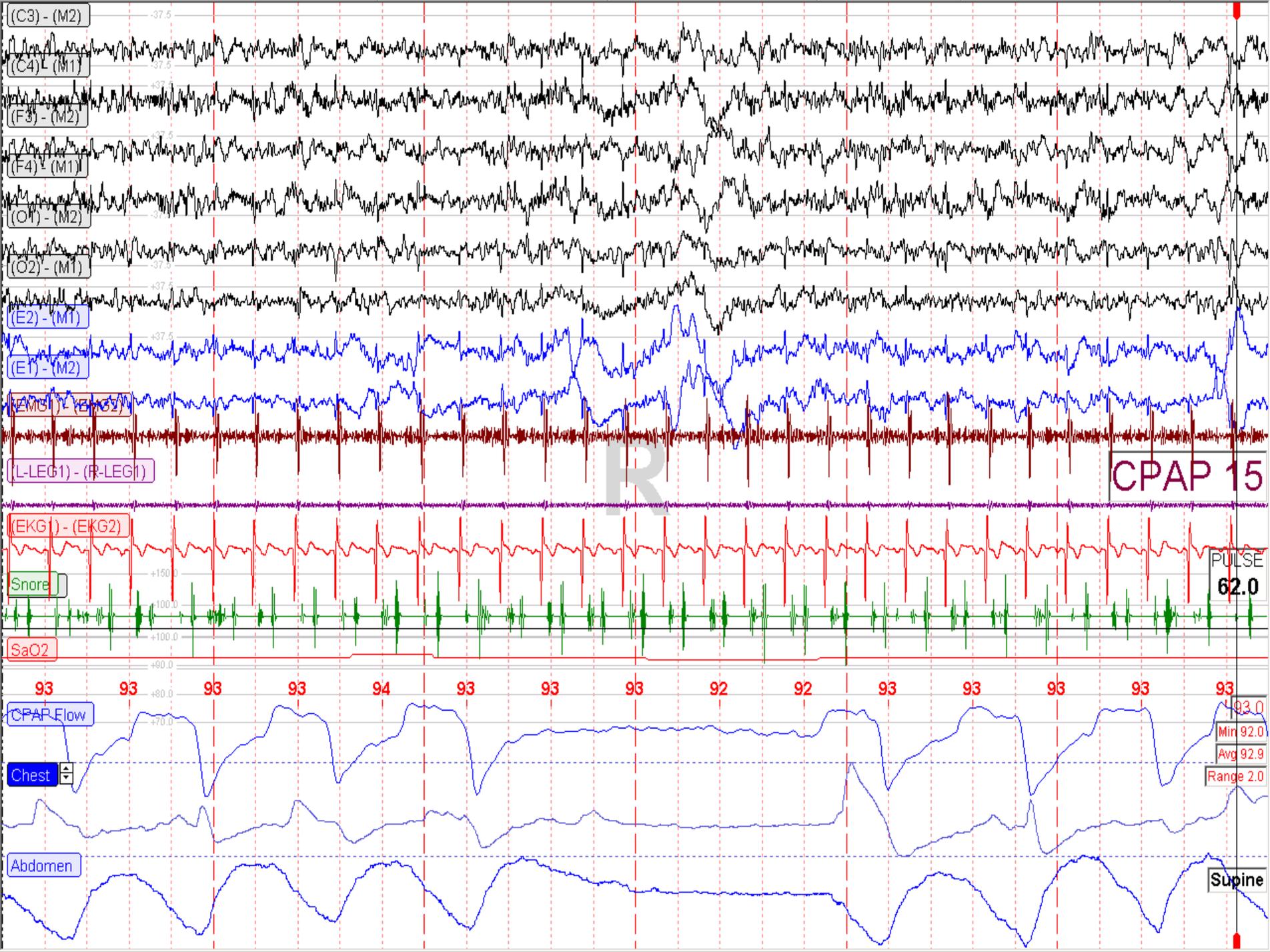
Stage R



Stage R







Stage REM

- ▣ Transient muscle activity replaces the terminology phasic twitches. These bursts are usually < 0.25 s and are superimposed on low EMG tone
- ▣ Can be observed in the chin EMG, anterior tibialis EMG, or EEG/EOG derivations
- ▣ Neither TMA or sawtooth waves are required to score stage REM, but each support the scoring of stage REM

Stage REM

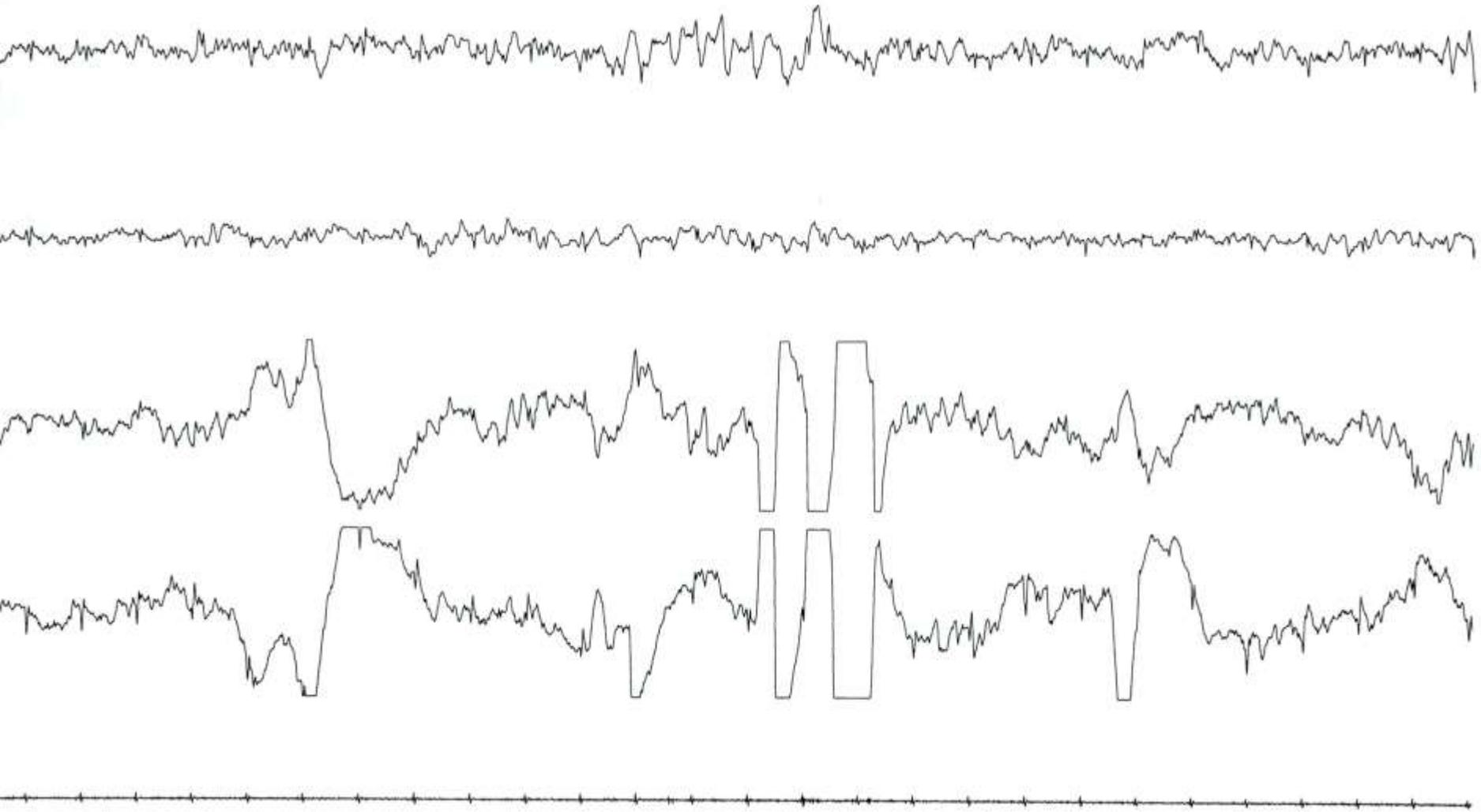
Score REM sleep on epochs with all of the following:

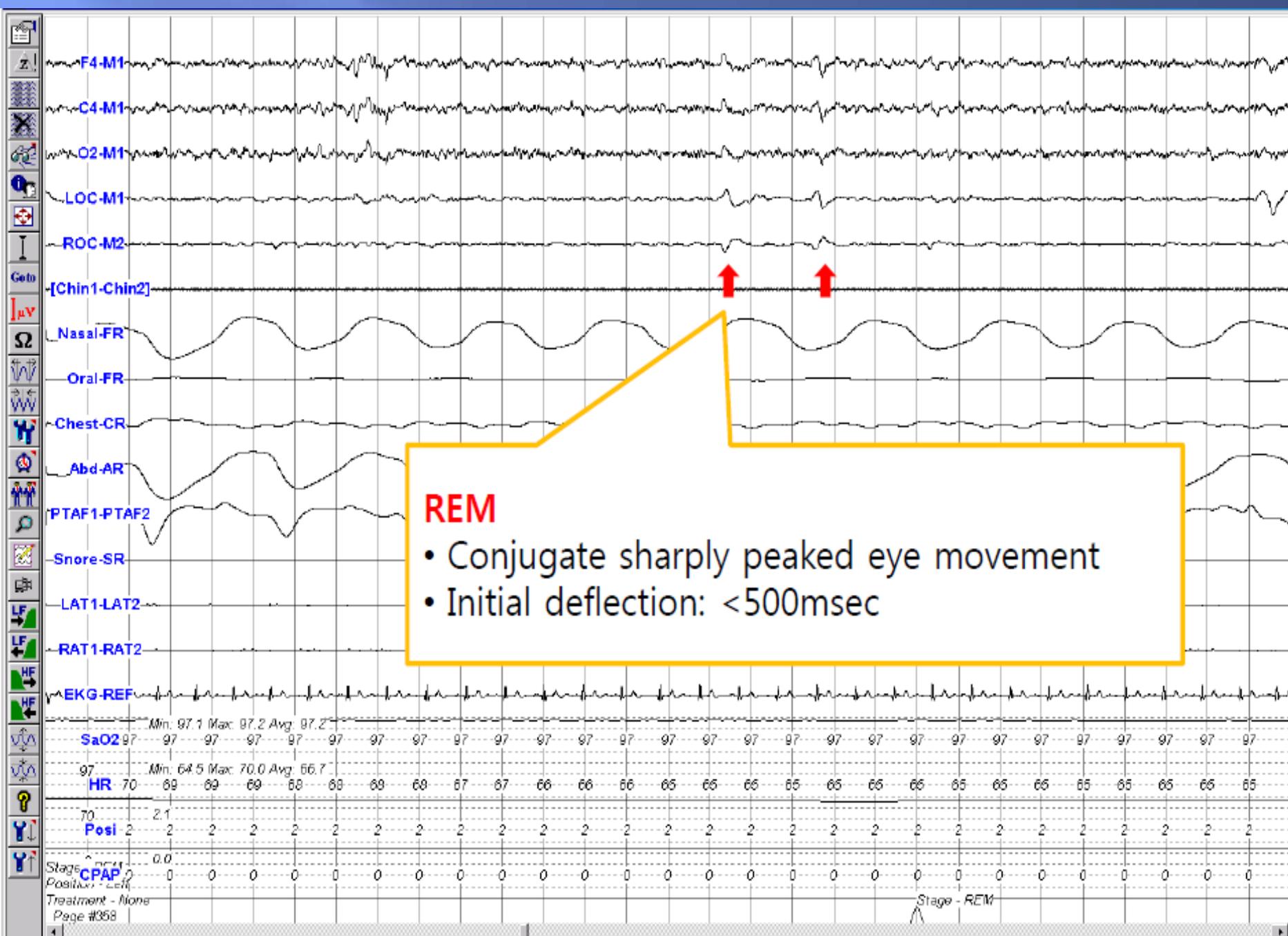
- Low-amplitude, mixed-frequency EEG activity
- Chin EMG tone is low (at its minimal level)
- Rapid eye movements are present

Continue to score REM, even in absence of REMs if:

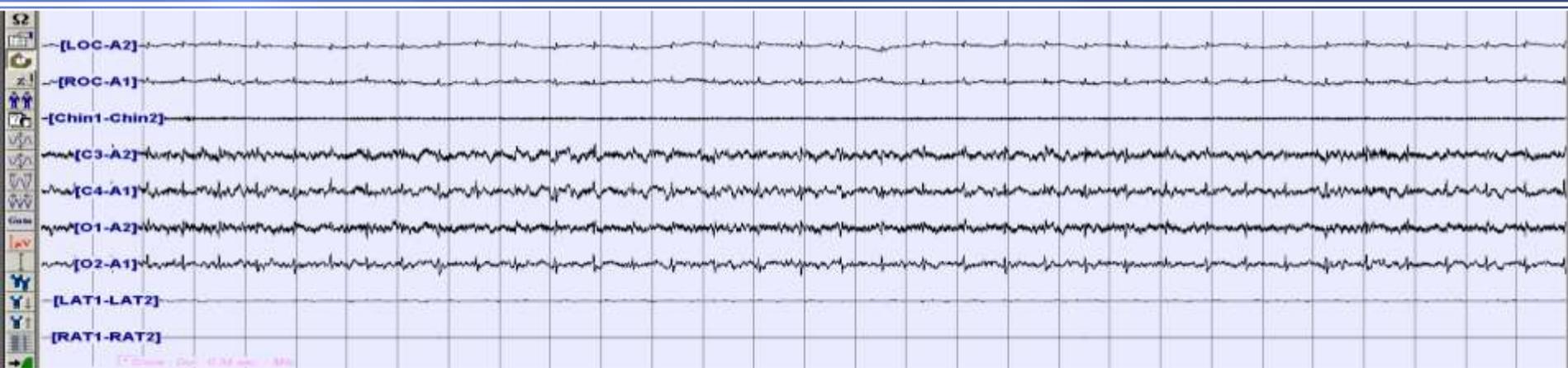
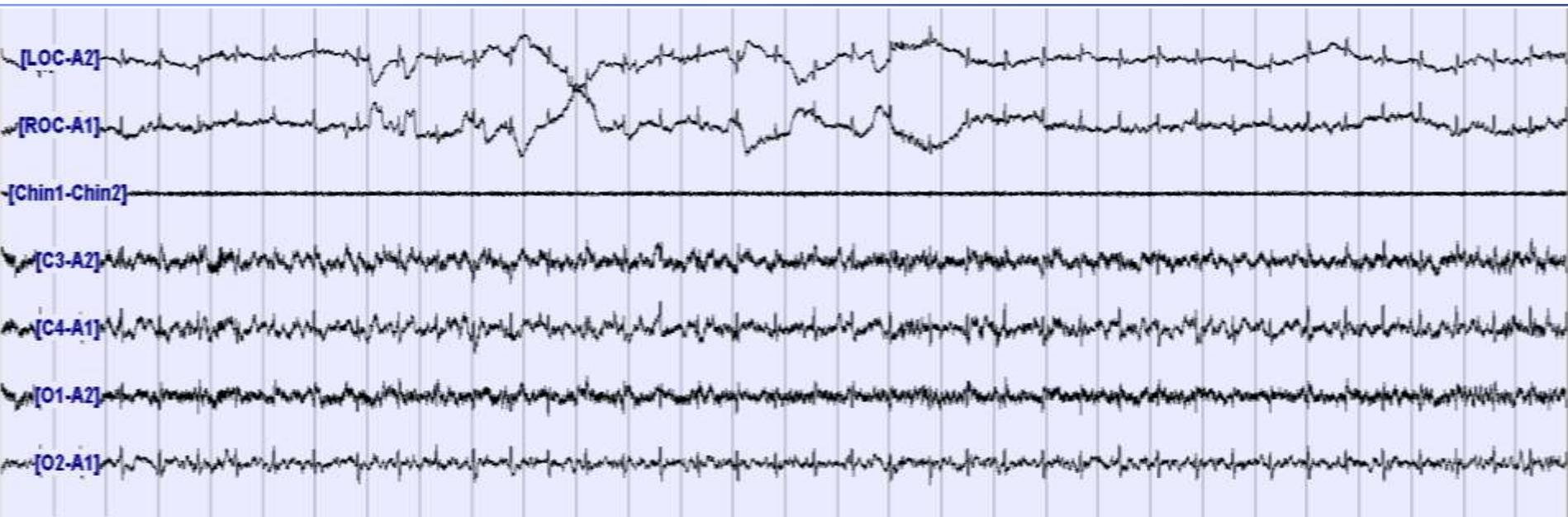
- The EEG remains LAMF
- The chin EMG tone remains relatively low
- There are no K complexes or sleep spindles

Phasic REM Sleep





Phasic and Tonic Stage R



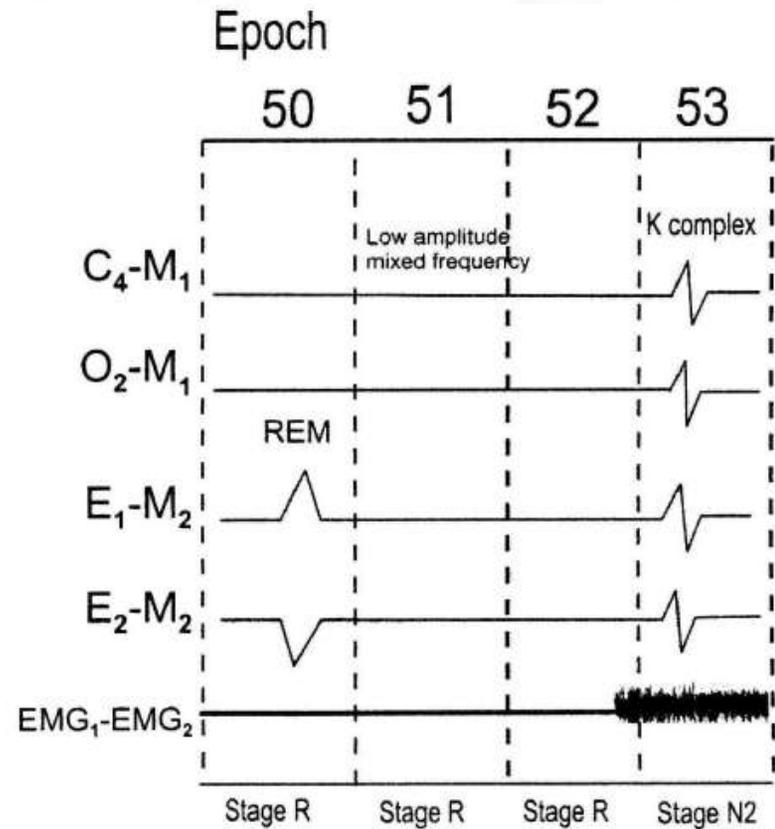
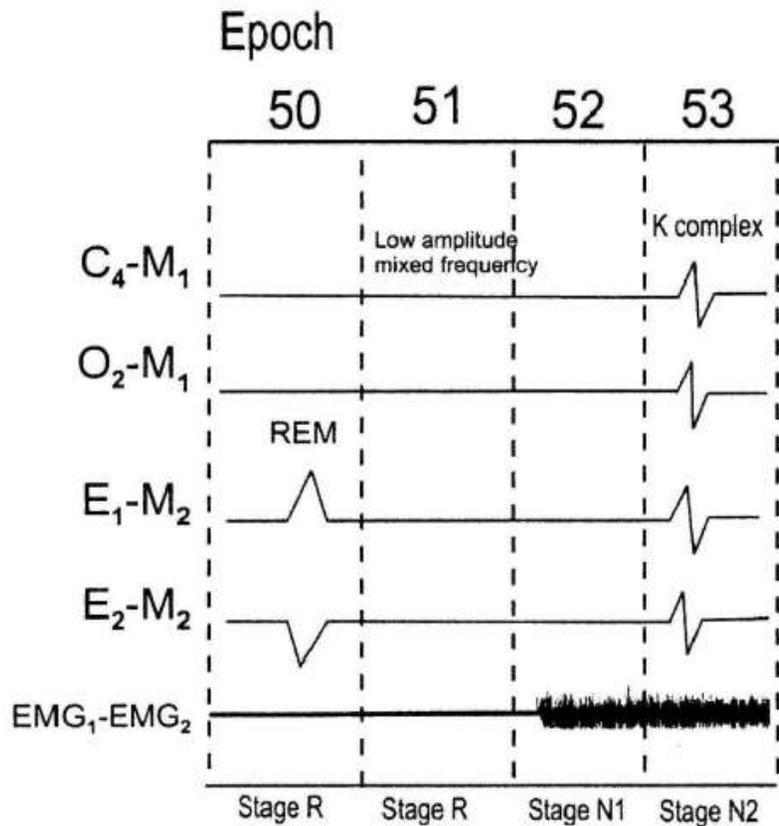
Stage REM

Discontinue REM sleep when:

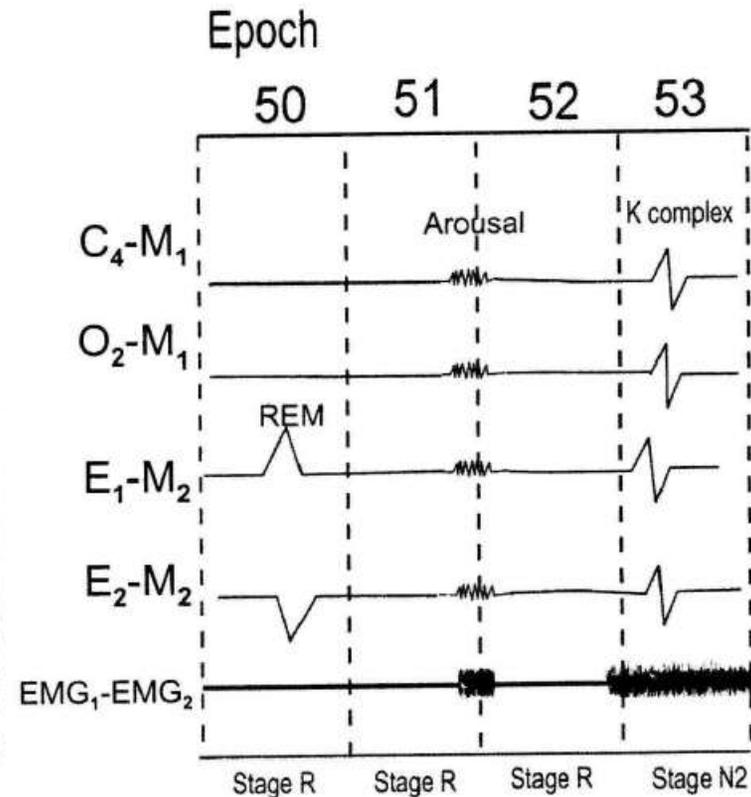
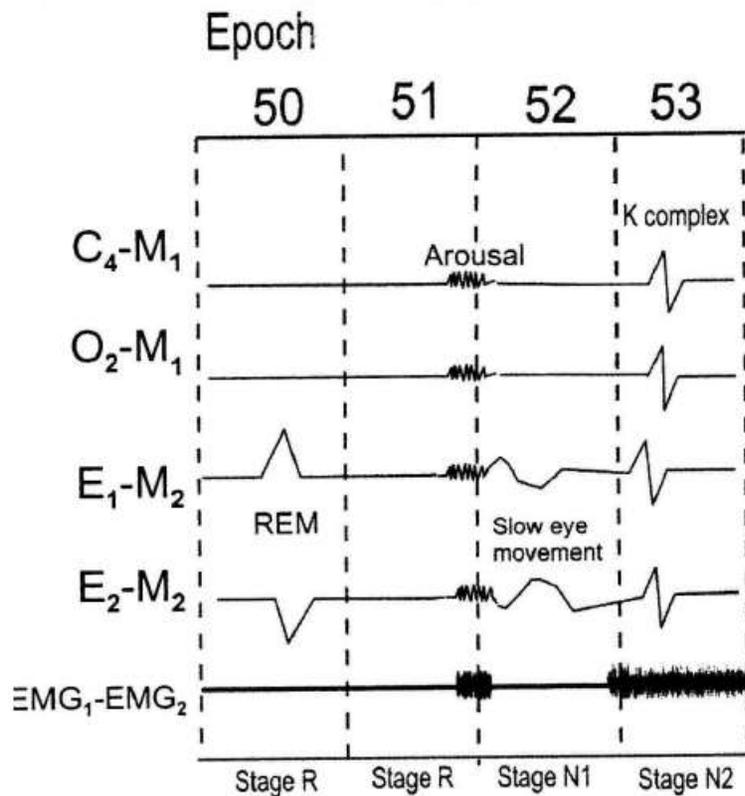
- There is transition to stage W or N3 (stage Δ)
- Chin EMG muscle tone increases (Stage N1)
- A K complex without arousal or a spindle occurs in first half of the epoch with no REMs (Stage N2)
- An arousal occurs followed by SEMs (or stage Δ)
- A major body movement is followed by SEMs (or stage Δ)

Ending Stage REM Sleep

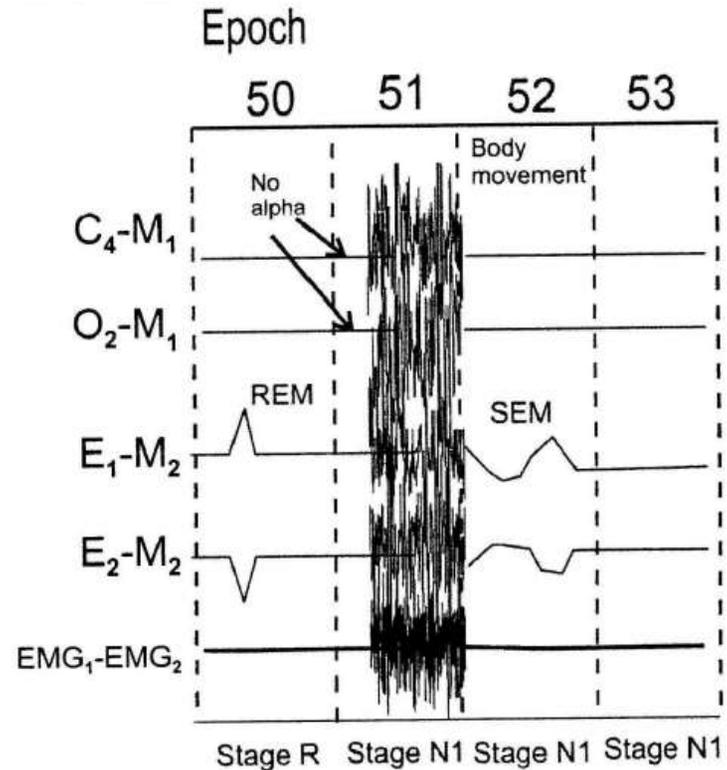
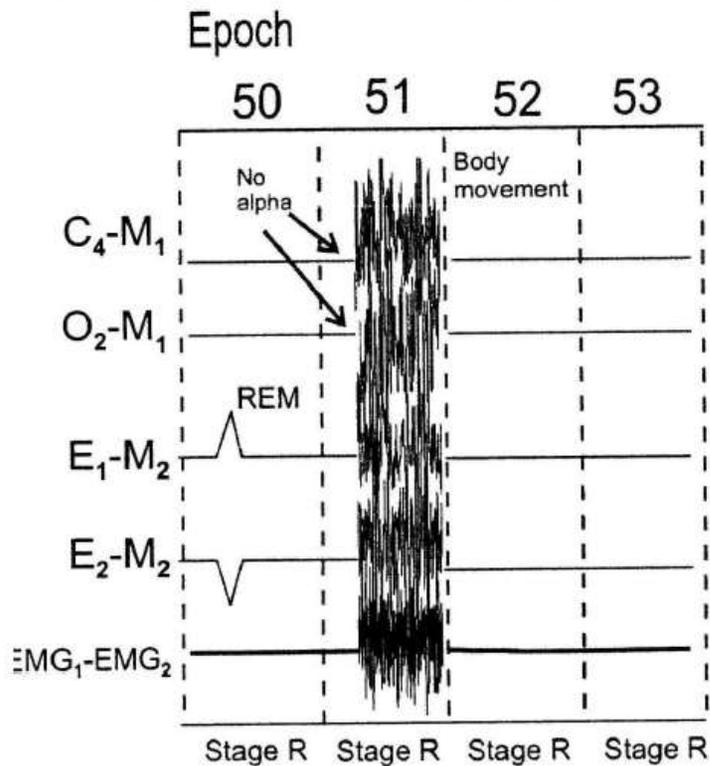
↑ EMG no REMs = stage Δ



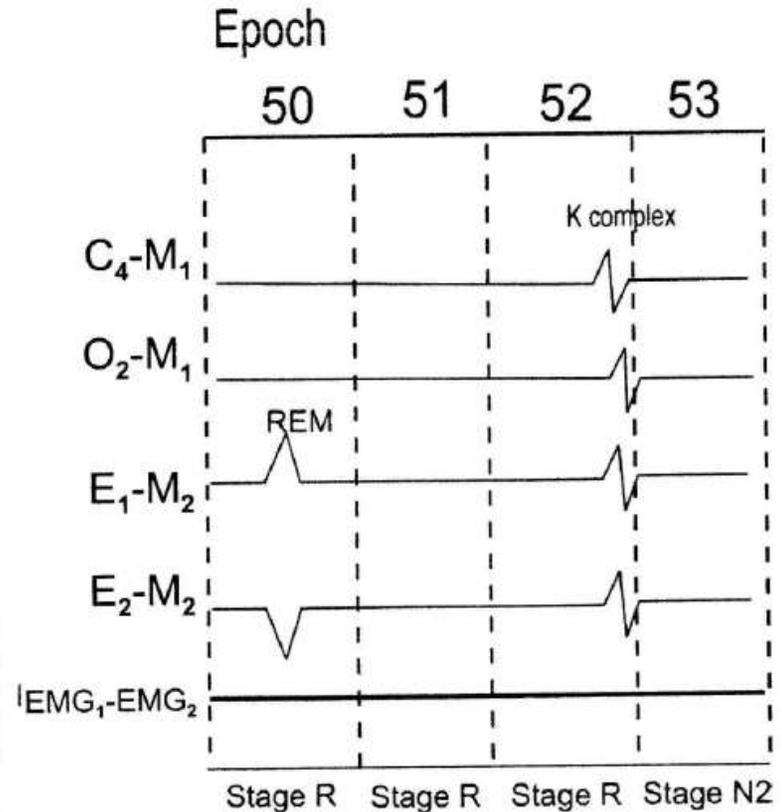
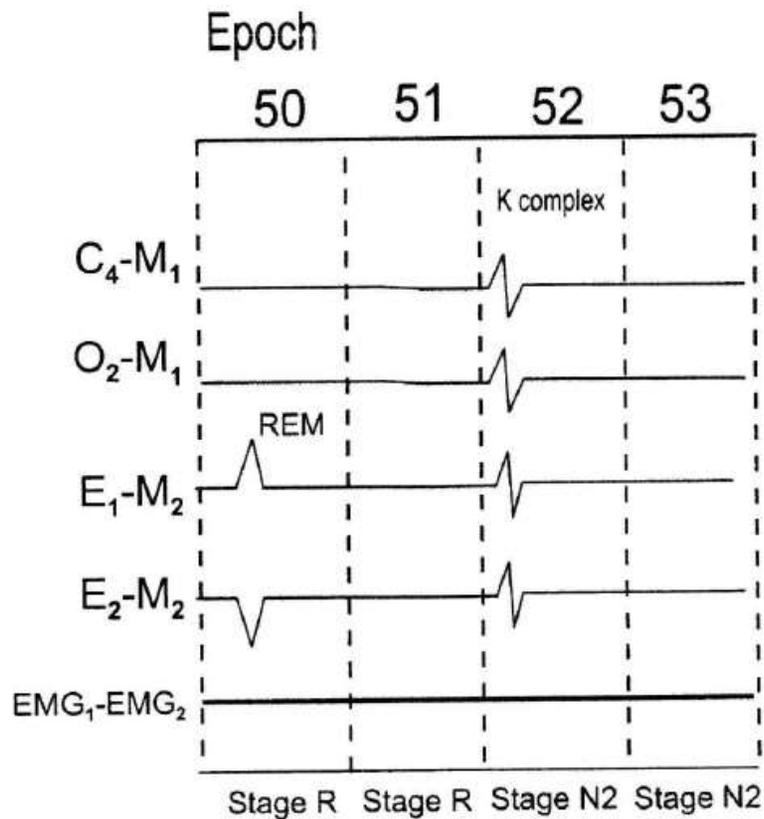
Ar+SEMs/EMG= stage Δ ; $\emptyset\Delta=R$



MBM \emptyset Δ =R; SEMs or EMG= Δ



No REMs with K/spindle = Δ

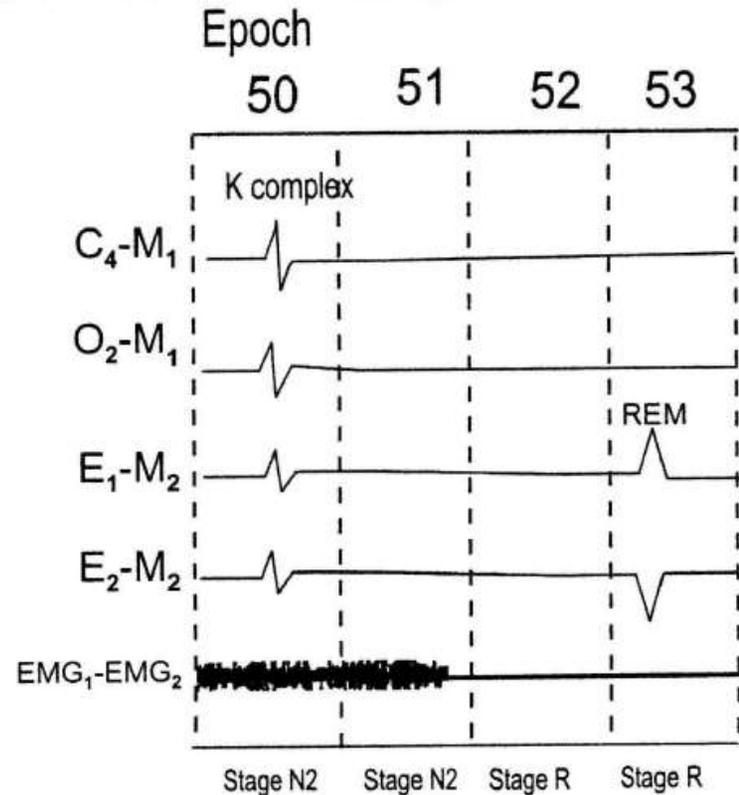
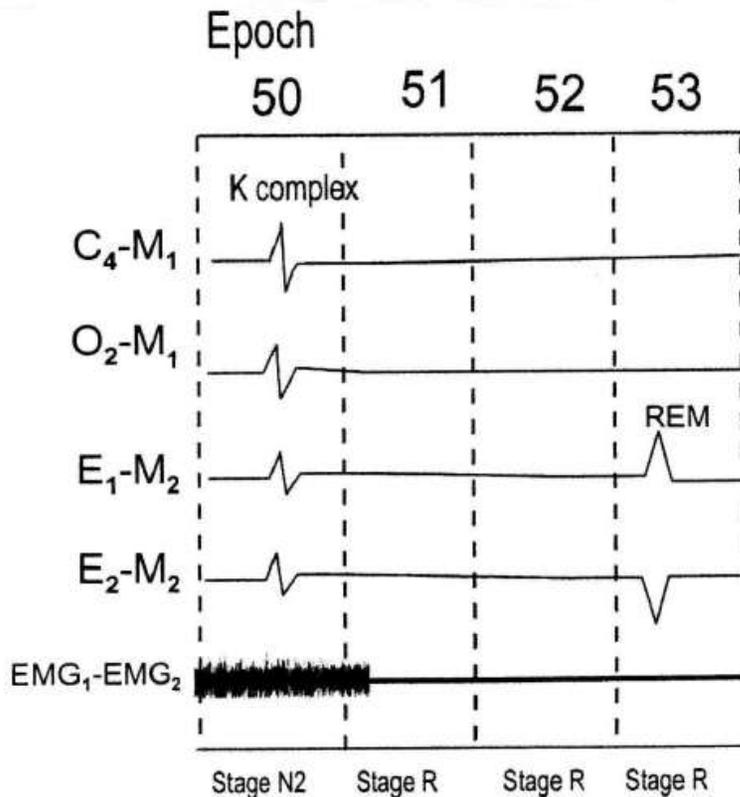


Stage N2 to REM Transitions

In between epochs of definite stage N2 and definite R, score an epoch with a distinct drop in chin EMG in the first half of the epoch to the level seen in stage R as stage R if all of following criteria are met, even in the absence of REMs:

- Absence of non-arousal associated K complexes
- Absence of sleep spindles

N2 to REM Transitions

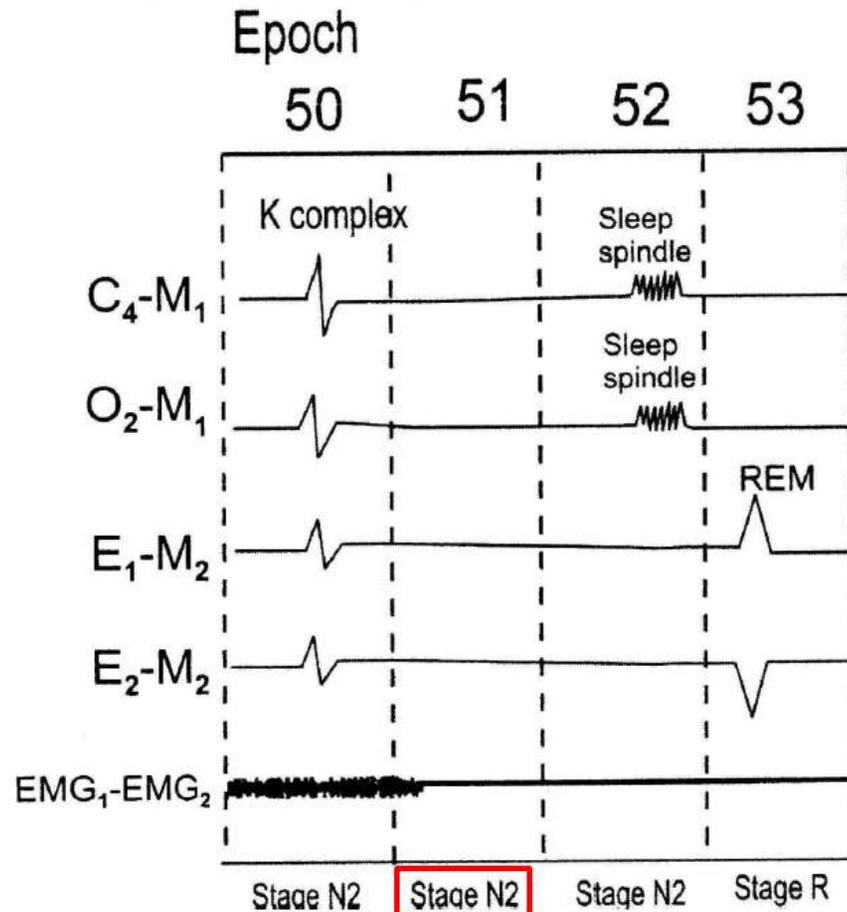


Stage N2 to REM Transitions

In between epochs of definite stage N2 and definite R, score an epoch with a distinct drop in chin EMG in the first half of the epoch to the level seen in stage R as stage N2 if all of following criteria are met:

- Presence of non-arousal associated K complexes or sleep spindles
- Absence of REMs

N2 to REM Transitions

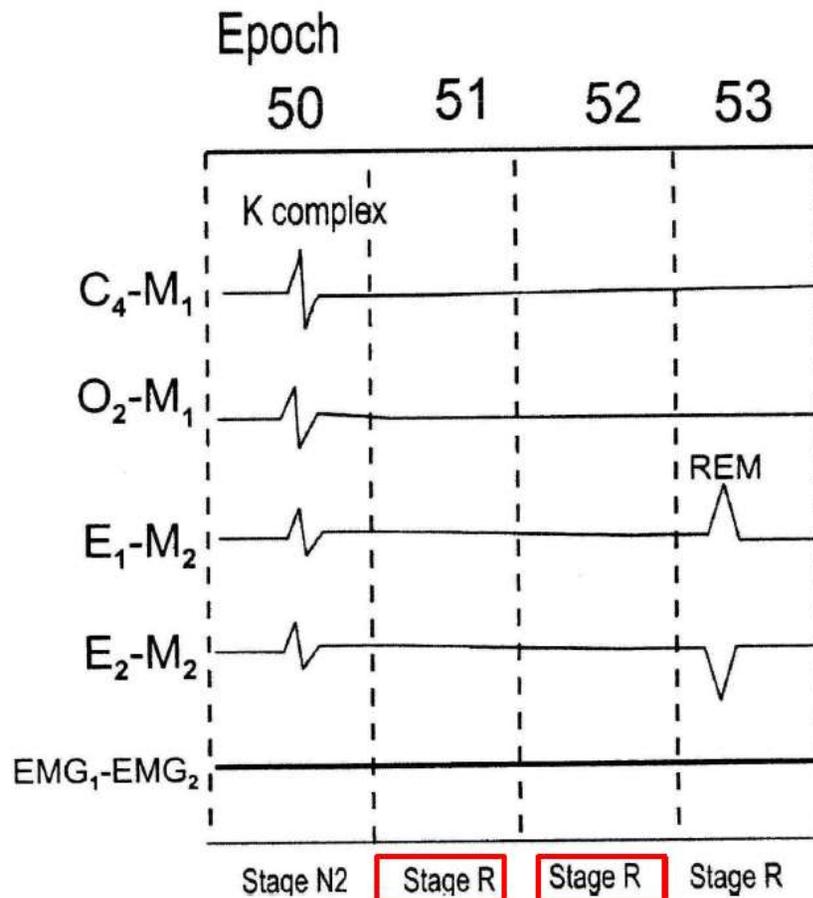


Stage N2 to REM Transitions

In between epochs of definite stage N2 with minimal chin EMG tone and definite R without further drop in chin EMG tone, score an epoch as stage R if all of following criteria are met, even in the absence of REMs

- Absence of non-arousal associated K complexes
- Absence of sleep spindles

N2 to REM Transitions



RESPIRATORY EVENTS

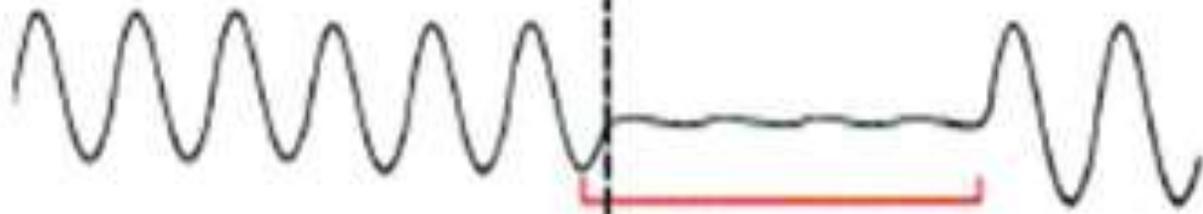
HOW TO MEASURE EVENTS

- 1. Apnea or Hypopnea:** The beginning of the event is from the nadir (lowest point) of the preceding breath (that is clearly reduced) to the beginning of the first breath that approximate the baseline amplitude.
2. Measure an **Apnea using the Oronasal Thermal** sensor and a **Hypopnea using the Pressure Transducer** if you are performing a diagnostic study. If you are performing a PAP titration, use the PAP device flow signal for determining the event duration.
3. When it's hard to easily determine the breathing amplitude, events can also be terminated when either there is a clear and sustained increase in breathing amplitude or, in the case where a desaturation has occurred, there is an event-associated resaturation of at least 2%.

Nasal
Pressure



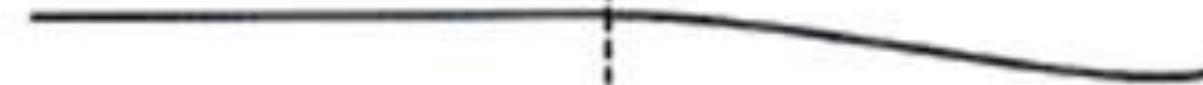
Thermal
Sensor



Inductance
Pleth Sum



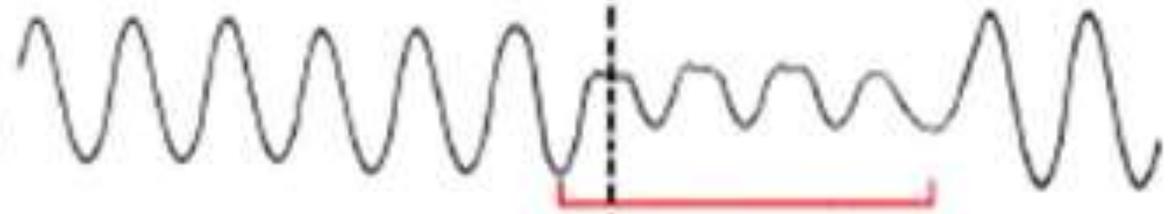
SpO₂



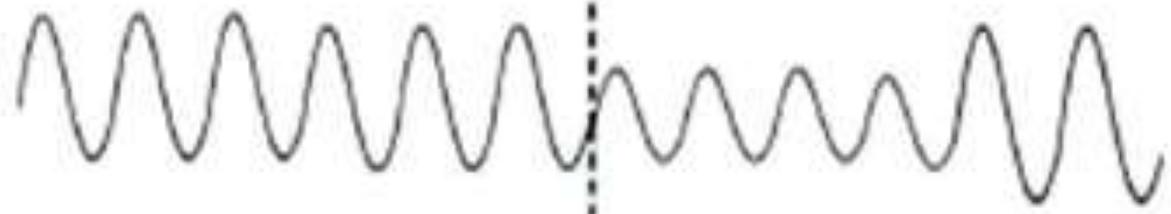
10 sec



Nasal Pressure



Thermal Sensor



Inductance Pleth Sum



SpO₂



10 sec



SCORING OF APNEAS

An APNEA must have BOTH of the following:

1. Drop in peak signal excursion by $\geq 90\%$ of pre-event baseline
 - a) Oronasal thermal sensor – diagnostic
 - b) PAP device flow – therapeutic
 - c) Alternative sensor – diagnostic
2. Score as **Obstructive Apnea** if associated with continued or increased inspiratory effort throughout the entire period of absent airflow.
3. Score as **Central Apnea** if associated with absent inspiratory effort throughout entire period of absent airflow.
4. Score as **Mixed Apnea** if inspiratory effort is absent at the beginning of the event but resumes in the second portion of the event.

More on Apnea Scoring...

1. You DO NOT have to have a desaturation to score an apnea!
2. If a bit of the respiratory event that would otherwise meet criteria for a hypopnea meets the criteria for Apnea, the entire event should be scored as an apnea!
3. If the apnea or hypopnea begins or ends in an epoch scored as sleep, this event is computed in the AHI. However, if the "apnea" or "hypopnea" occurs exclusively in an epoch scored as wake, we do not count toward AHI. If this occurs frequently in the study, it should be addressed in the tech notes for the physician.
4. There's not enough evidence to support a specific duration of the central and obstructive components of a mixed apnea, therefore there is no recommendation.

Hypopnea Scoring

- ▣ Most significant changes in the scoring rules.
- ▣ Recommended rule changed.
- ▣ No acceptable rule is noted.
- ▣ Removed the 90% of event duration must meet amplitude reduction criteria.
- ▣ Added definitions for scoring obstructive and central hypopnea.
- ▣ Noted that it is optional to score hypopneas as central or obstructive.

Everything you ever wanted to know about.....

SCORING HYPOPNEAS!

It's a Hypopnea if *ALLLLLLL* of the following criteria are met:

1. Peak signal excursion drops by $\geq 30\%$ of pre-event baseline
 - a) Nasal Pressure (diagnostic)
 - b) PAP device flow (therapeutic)
 - c) Alternative hypopnea sensor (diagnostic)

2. The duration of the $\geq 30\%$ drop is ≥ 10 seconds.

3. There is a $\geq 3\%$ or 4% oxygen desaturation from pre-event baseline or the event is associated with an arousal.* Rule 1A or 1B

D. Scoring of Hypopneas

Scoring hypopneas as central or obstructive events is optional as noted in Parameters to be Reported (ILF).

1A. Score a respiratory event as a hypopnea if ALL of the following criteria are met:^{N1,N2,N3} (see Figure 2) **RECOMMENDED**

- The peak signal excursions drop by $\geq 30\%$ of pre-event baseline using nasal pressure (diagnostic study), PAP device flow (titration study), or an *alternative* hypopnea sensor (diagnostic study).
- The duration of the $\geq 30\%$ drop in signal excursion is ≥ 10 seconds.
- There is a $\geq 3\%$ oxygen desaturation from pre-event baseline or the event is associated with an arousal.

1B. Score a respiratory event as a hypopnea if ALL of the following criteria are met:^{N1,N2,N3} **ACCEPTABLE**

- The peak signal excursions drop by $\geq 30\%$ of pre-event baseline using nasal pressure (diagnostic study), PAP device flow (titration study), or an *alternative* hypopnea sensor (diagnostic study).
- The duration of the $\geq 30\%$ drop in signal excursion is ≥ 10 seconds.
- There is a $\geq 4\%$ oxygen desaturation from pre-event baseline.

But wait...there's more!!!

You can differentiate between Obstructive and Central Hypopneas!

If scoring **Obstructive Hypopneas**, one of the following must be met:

1. Snoring during the event
2. Increased inspiratory flattening of the nasal pressure or PAP device flow signal compared to baseline
3. Associated thoracoabdominal paradox occurs during the event but not during pre-event breathing

If scoring **Central Hypopneas**, NONE of the following must be present:

1. Snoring during the event
2. Increased inspiratory flattening of the nasal pressure or PAP device flow signal compared to baseline
3. Associated thoracoabdominal paradox occurs during the event but not during pre-event breathing

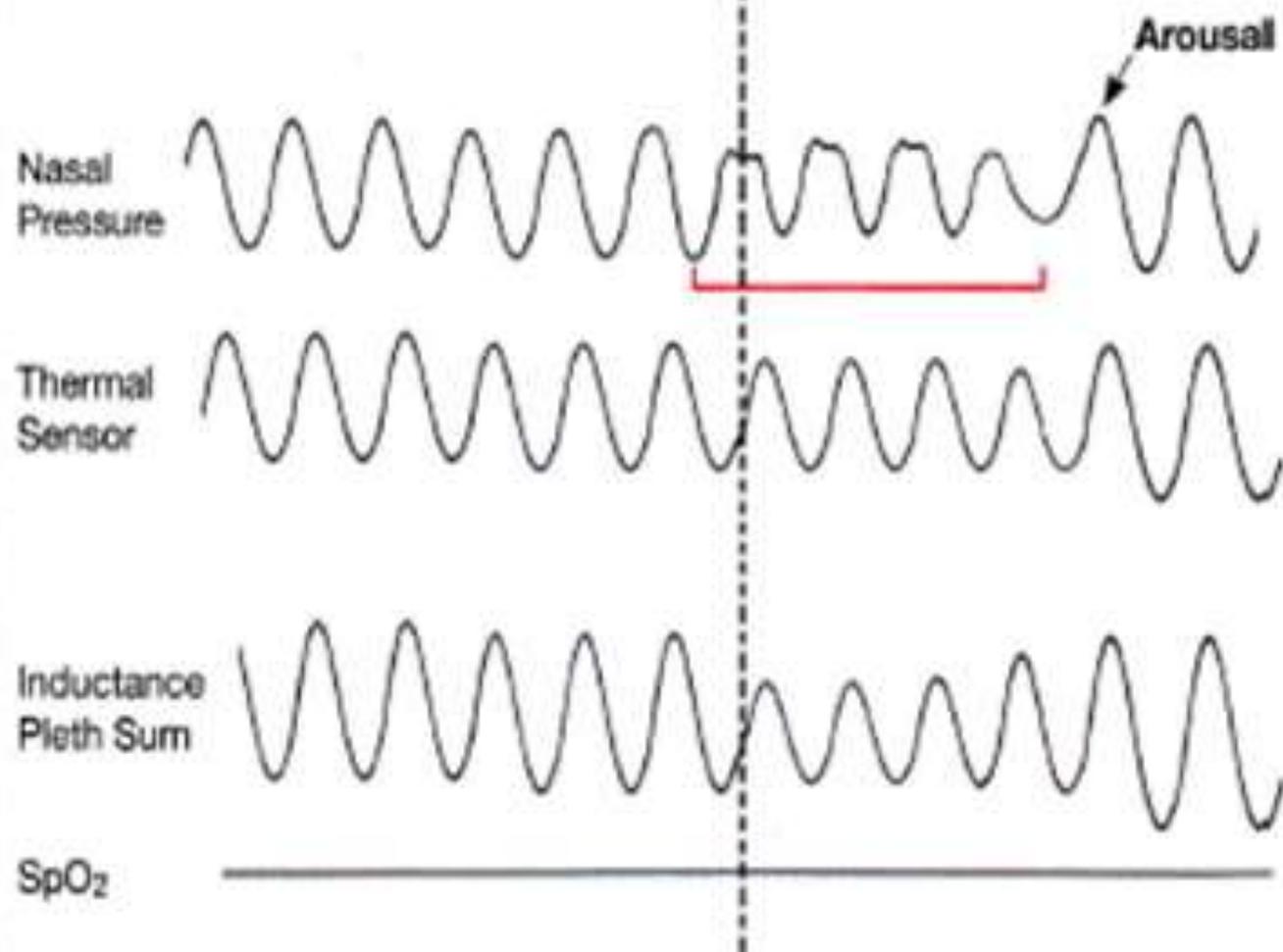
The “Fine Print”....

- Note 1. Identification of an apnea does not require a minimum desaturation criterion.
- Note 2. If a portion of a respiratory event that would otherwise meet criteria for a hypopnea meets criteria for apnea, the entire event should be scored as an apnea.
- Note 3. **If the apnea or hypopnea event begins or ends during an epoch that is scored as sleep, then the corresponding respiratory event can be scored and included in the computation of the apnea hypopnea index (AHI).** This situation usually occurs when an individual has a high AHI with events occurring so frequently that sleep is severely disrupted and epochs may end up being scored as wake even though <15 seconds of sleep is present during the epoch containing that portion of the respiratory event. However, if the apnea or hypopnea occurs entirely during an epoch scored as wake, it should not be scored or counted towards the apnea hypopnea index because of the difficulty of defining a denominator in this situation. If these occurrences are a prominent feature of the polysomnogram and/or interfere with sleep onset, their presence should be mentioned in the narrative summary of the study.
- Note 4. For *alternative* apnea sensors see Technical Specifications for adults (A.2).
- Note 5. There is not sufficient evidence to support a specific duration of the central and obstructive components of a mixed apnea; thus, specific durations of these components are not recommended.

Supplemental oxygen may “blunt” desaturation. There are currently no scoring guidelines for when a patient is on supplemental oxygen and no desaturation is noted. If the diagnostic study is performed while the subject is on supplemental oxygen, its presence should be mentioned in the narrative summary of the study.

Let's talk about RERA's...

- An optional parameter...in my opinion, valid reporting tool.
- Score as *Respiratory Event Related Arousals (RERA)* if there is a sequence of breaths lasting ≥ 10 seconds characterized by increasing respiratory effort OR flattening of the inspiratory portion of the nasal pressure channel or PAP device flow waveforms leading to AROUSAL from sleep.
- Hypopnea "wannabes."



SCORING HYPOVENTILATION....

Monitoring hypoventilation is an optional parameter to be reported but I personally feel it is a critical item.

Score a Respiratory event as a hypoventilation during sleep if EITHER of the Below occur:

1. There is an increase in the arterial PCO₂ (or surrogate) to a value of $> 55\text{mmHg}$ for ≥ 10 minutes.
2. There is ≥ 10 mmHg increase in arterial PCO₂ (or surrogate) during sleep (in comparison to an awake supine value) to a value exceeding 50 mmHg ≥ 10 minutes.

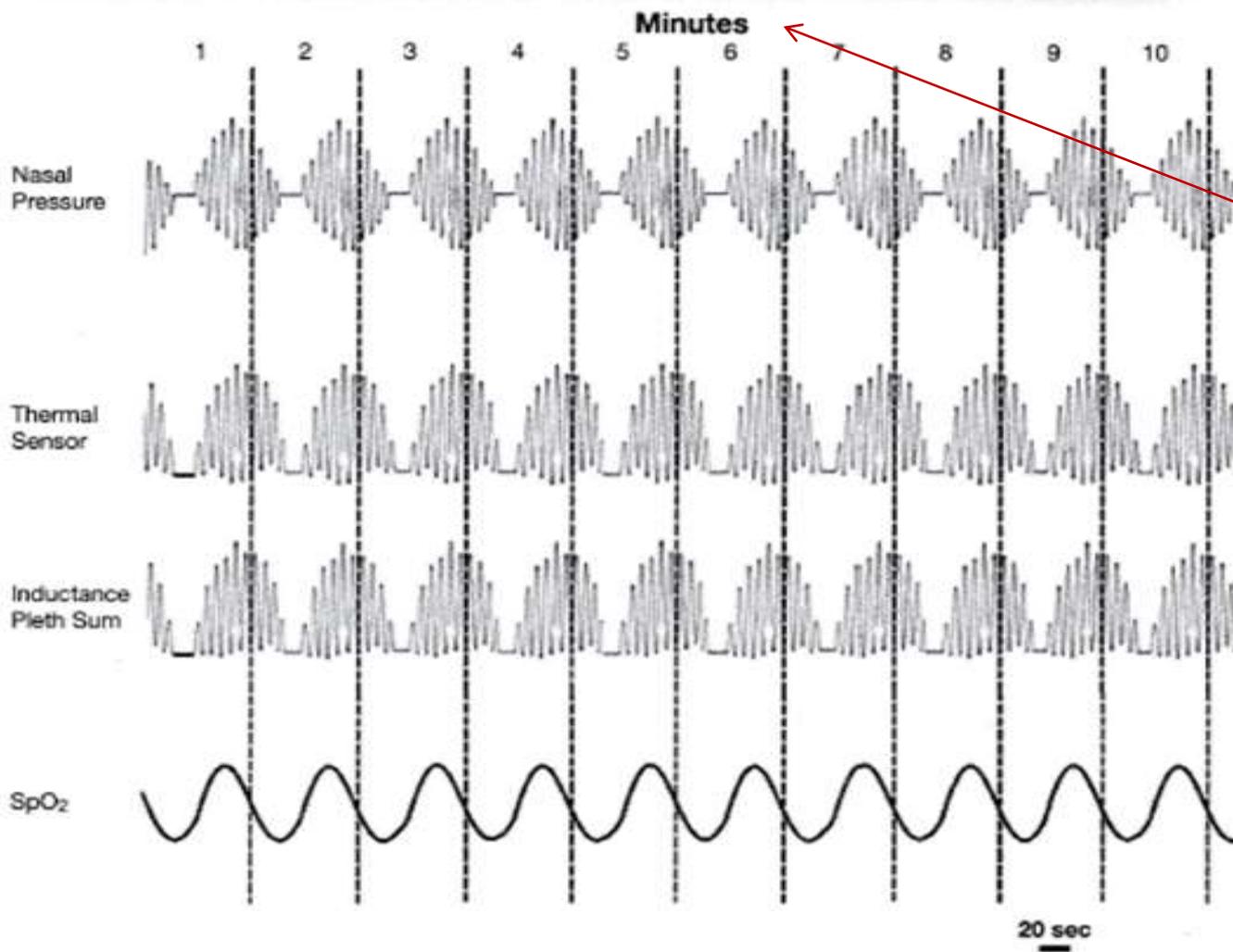
Surrogate = TcCO₂ monitor

Cheyne-Stokes Breathing

Rule has been updated and language changed:

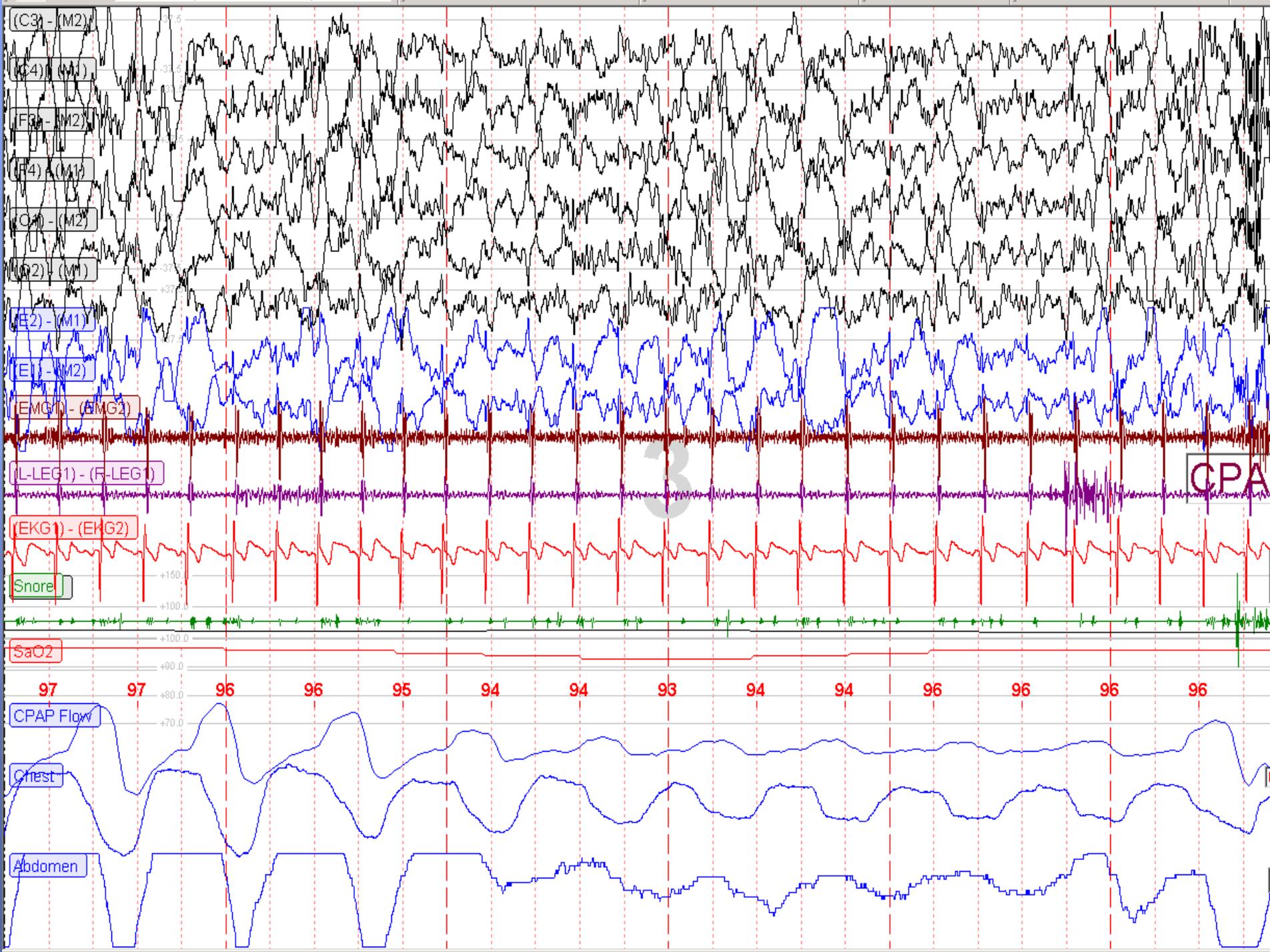
There are episodes of ≥ 3 consecutive central apneas and/or central hypopneas separated by a crescendo and decrescendo change in breathing amplitude with a cycle length of ≥ 40 seconds.

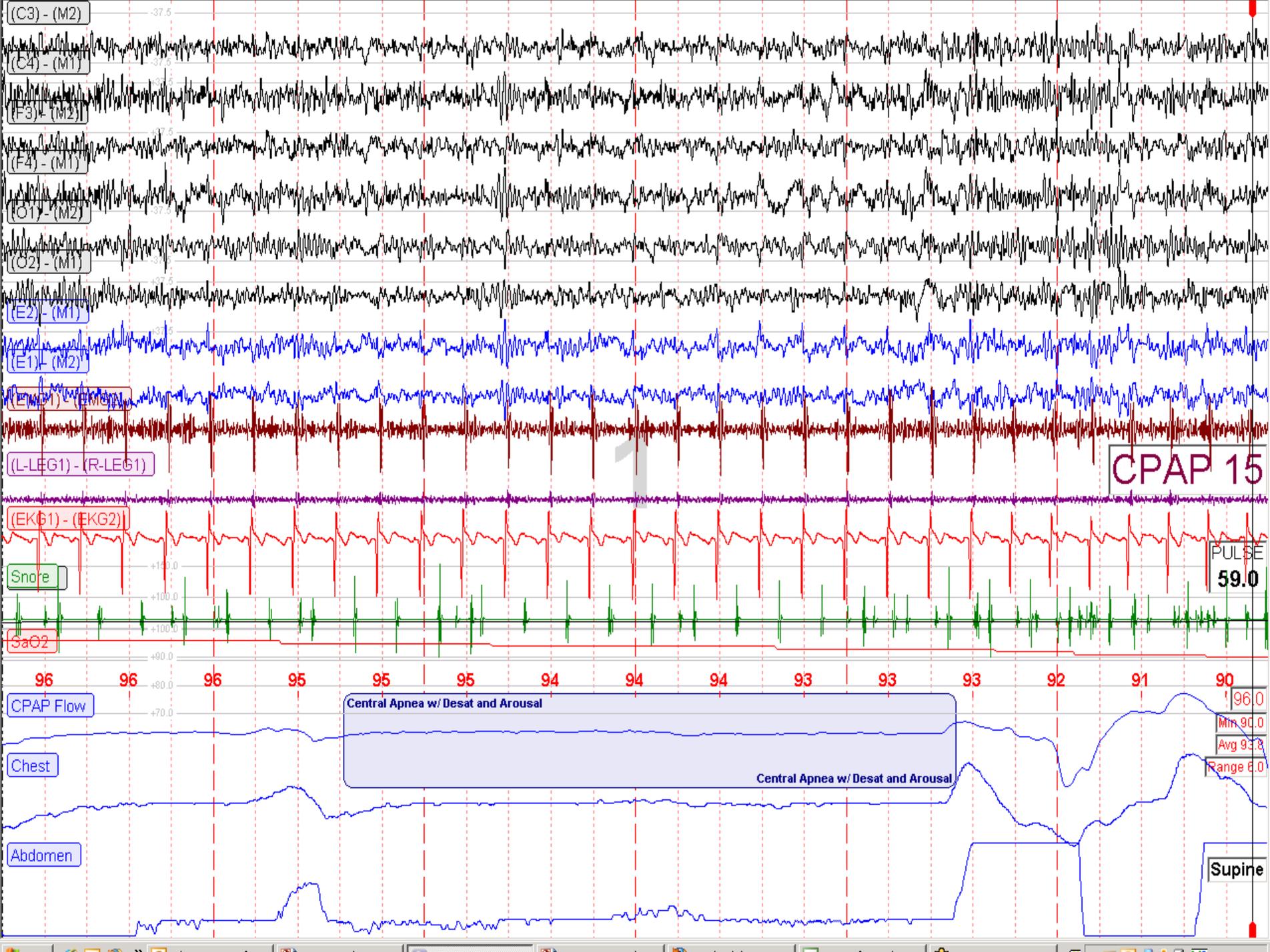
There are ≥ 5 central apneas and/or central hypopneas per hour of sleep associated with the crescendo/decrecendo breathing pattern recorded over ≥ 2 hours of monitoring.

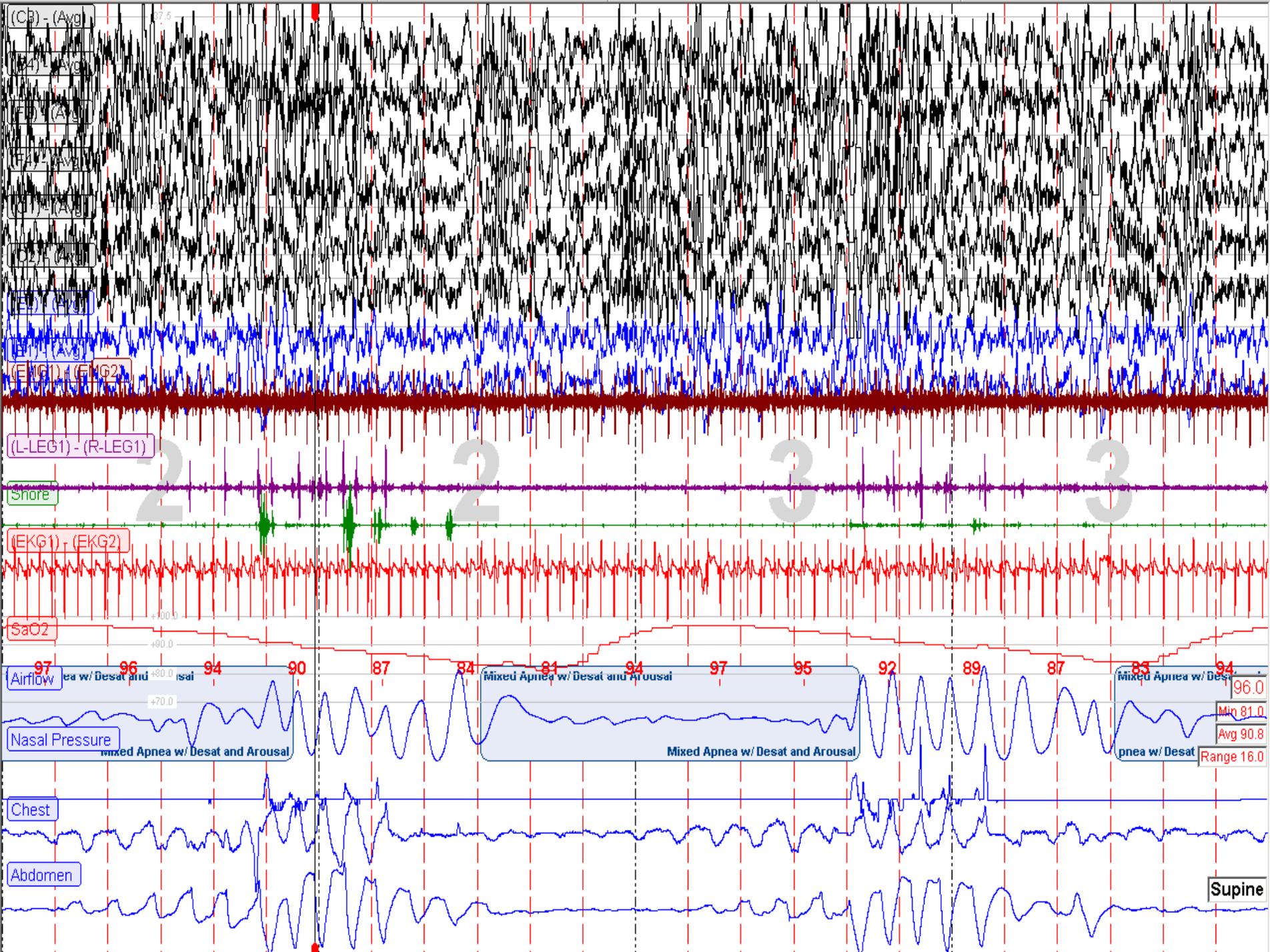


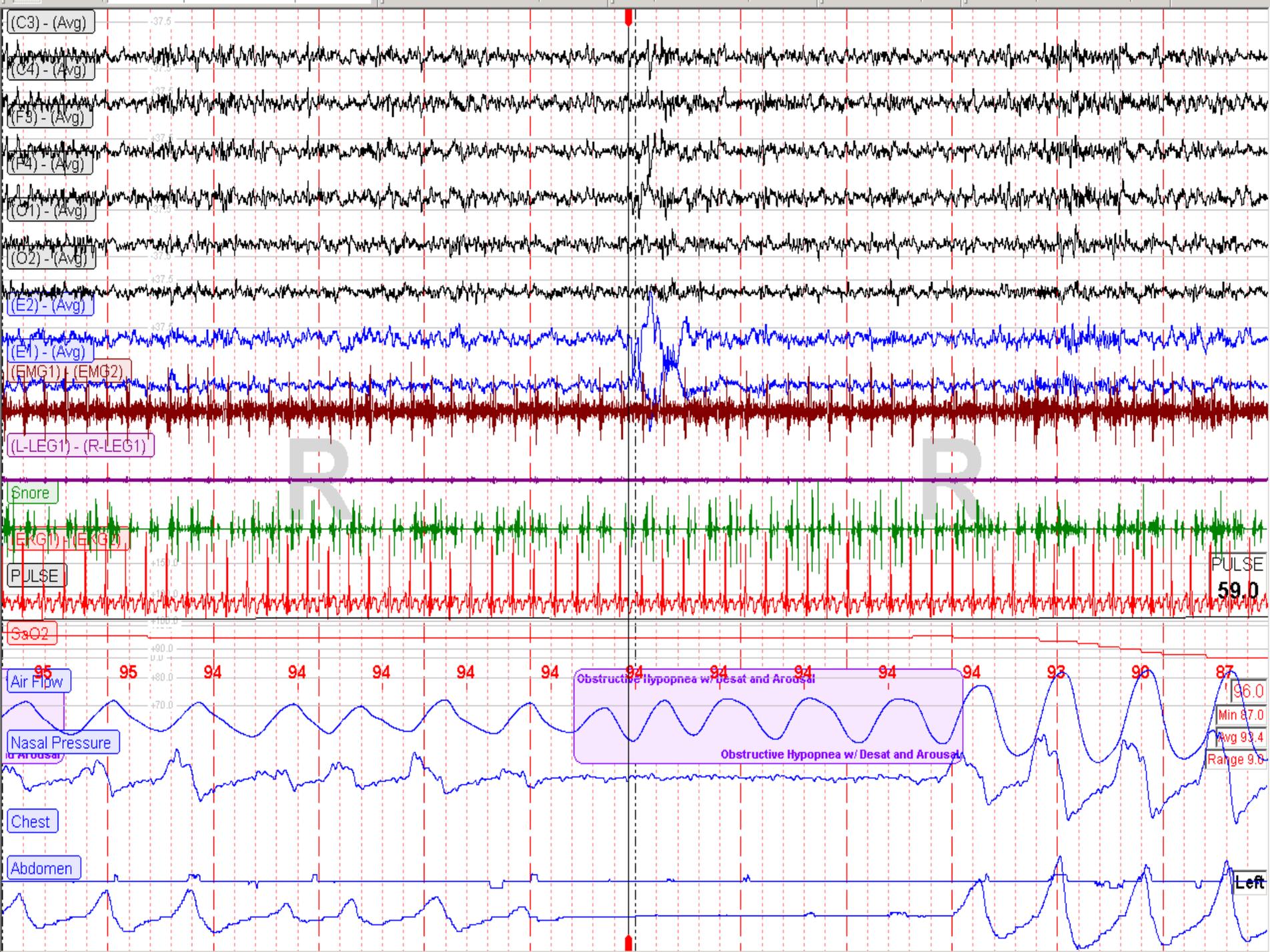
More than 40 secs. duration

- Note 1. Cycle length is the time from the beginning of a central apnea to the end of the next crescendo-decrescendo respiratory phase (start of the next apnea).
- Note 2. Central apneas that occur within a run of Cheyne-Stokes breathing should be scored as individual apneas as well.









PULSE
59.0

Obstructive Hypopnea w/ Desat and Arousal

96.0
Min 87.0
Avg 93.4
Range 9.0

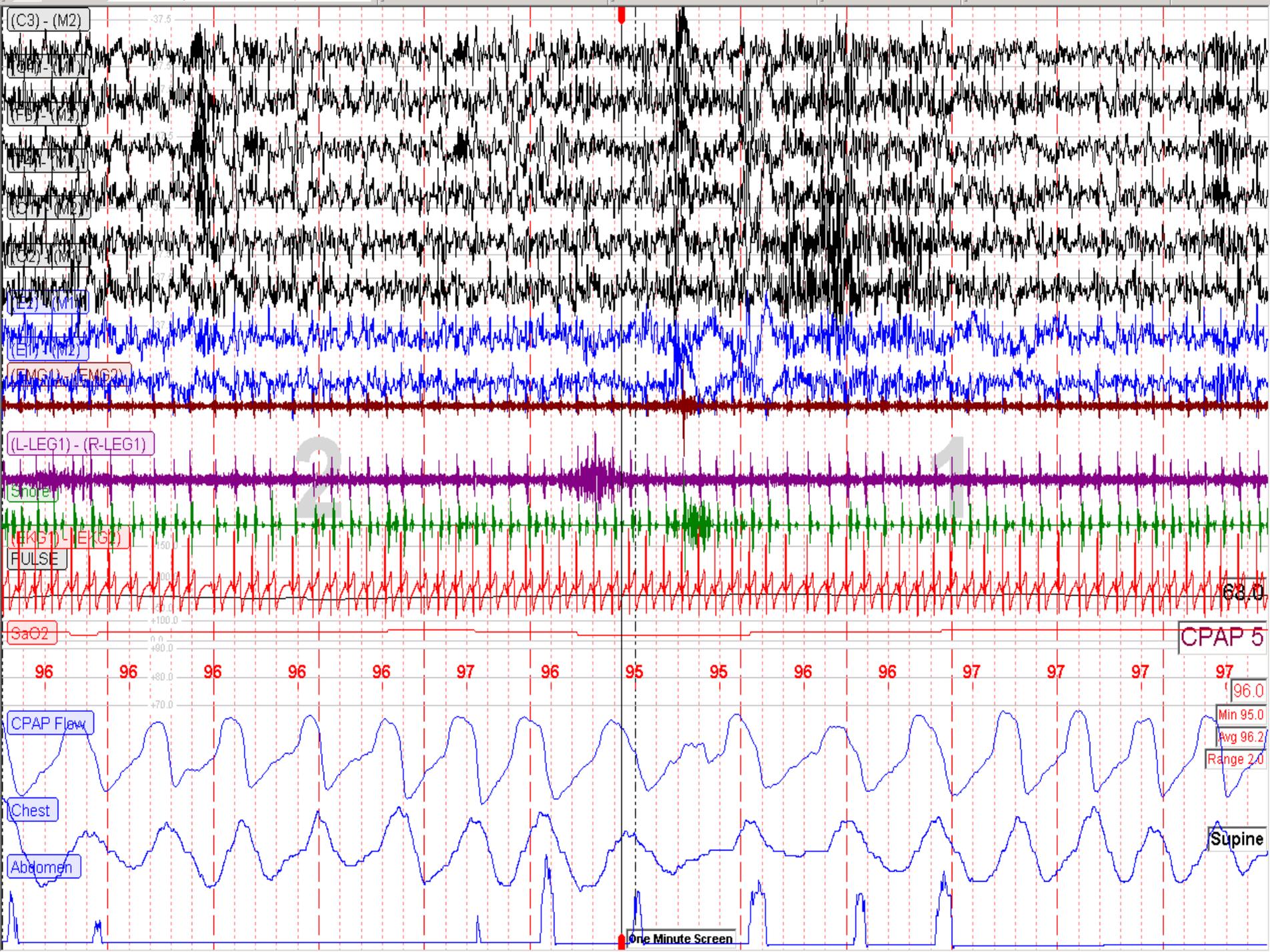
Left

EEG AROUSALS

- ▣ Scoring during any stage of sleep if there is an abrupt shift of EEG frequency including alpha, theta, and/or frequencies > 16 Hz (but not spindles) that lasts at least 3 seconds, with at least 10 seconds of stable sleep preceding the change.

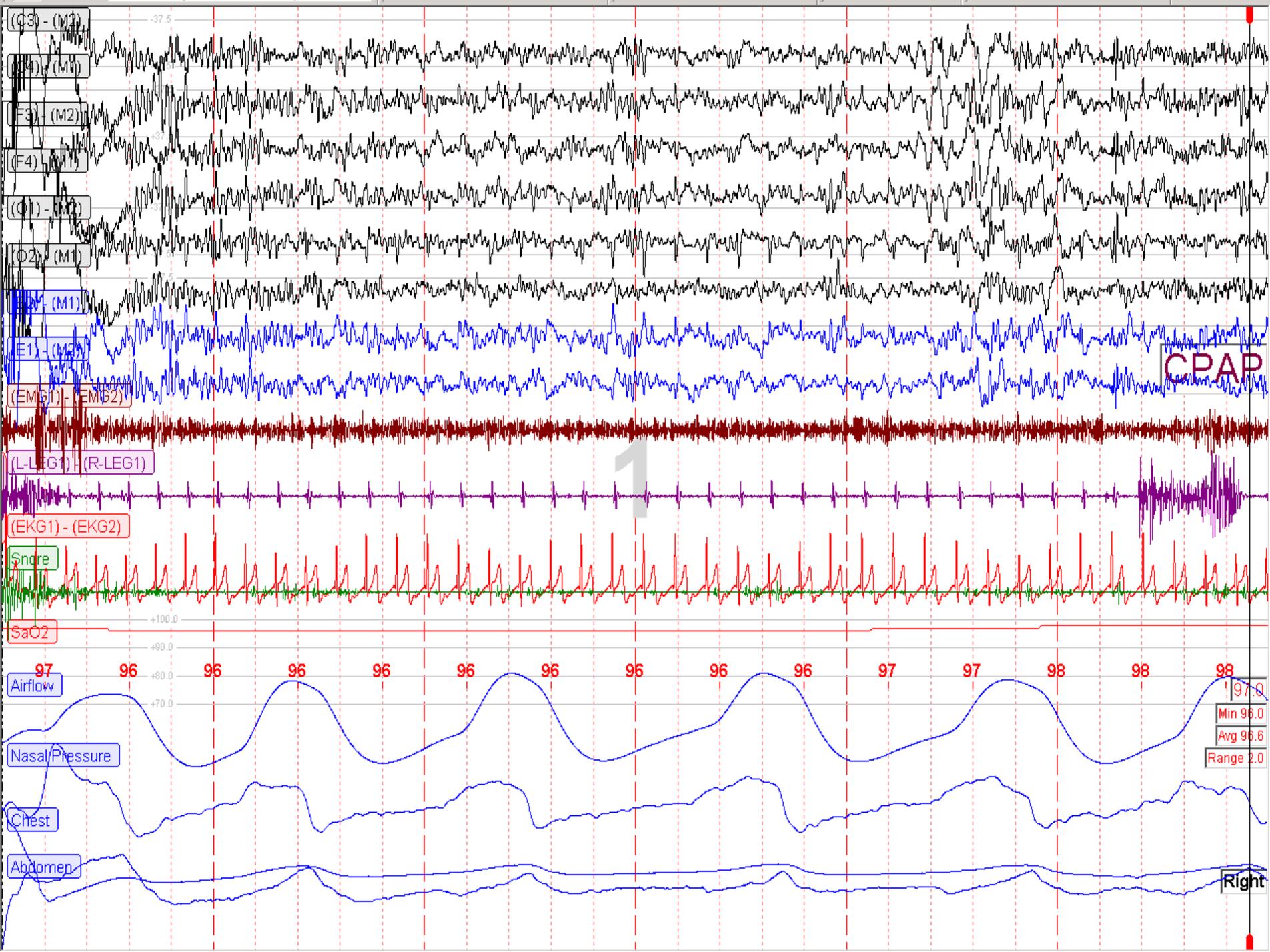
Rule #1

- ▣ Subjects must be asleep, defined as ≥ 10 continuous seconds of the indication of any stage of sleep, before an EEG arousal can be scored.



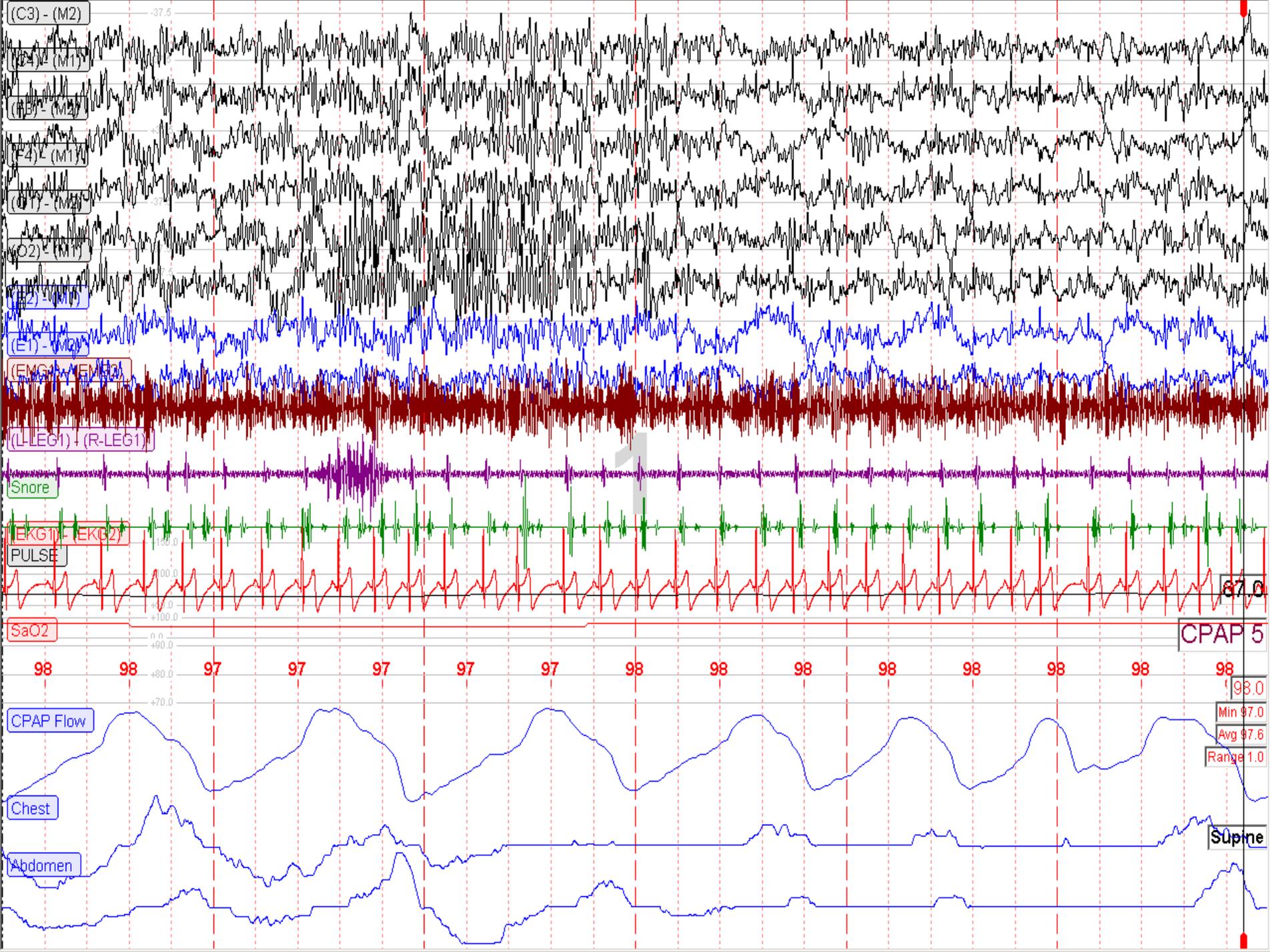
Rule #2

- ▣ A minimum of 10 continuous seconds of intervening sleep is necessary to score a second arousal.



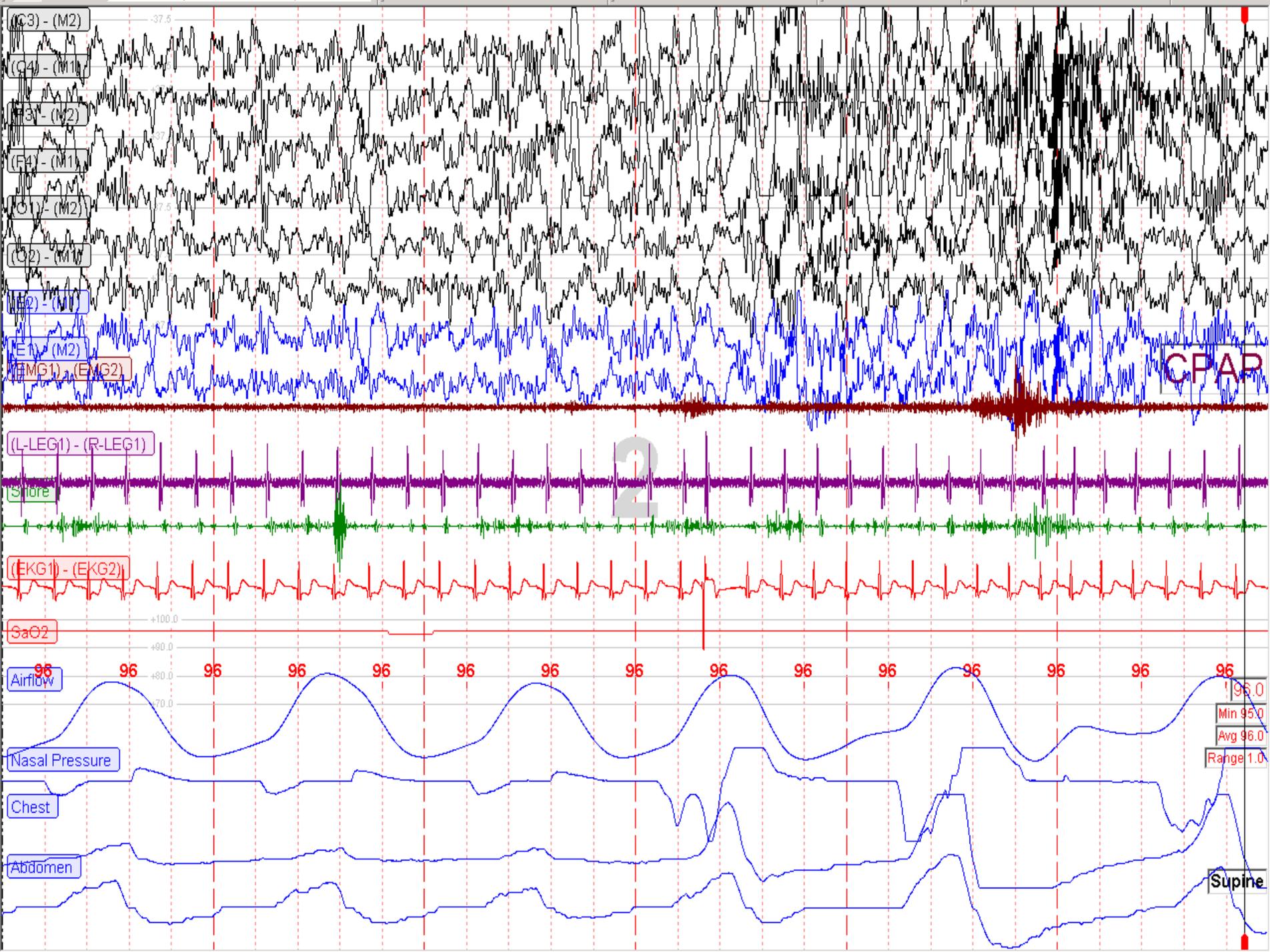
Rule #3

- ▣ The EEG frequency shift must be 3 seconds or greater in duration to be scored as an arousal



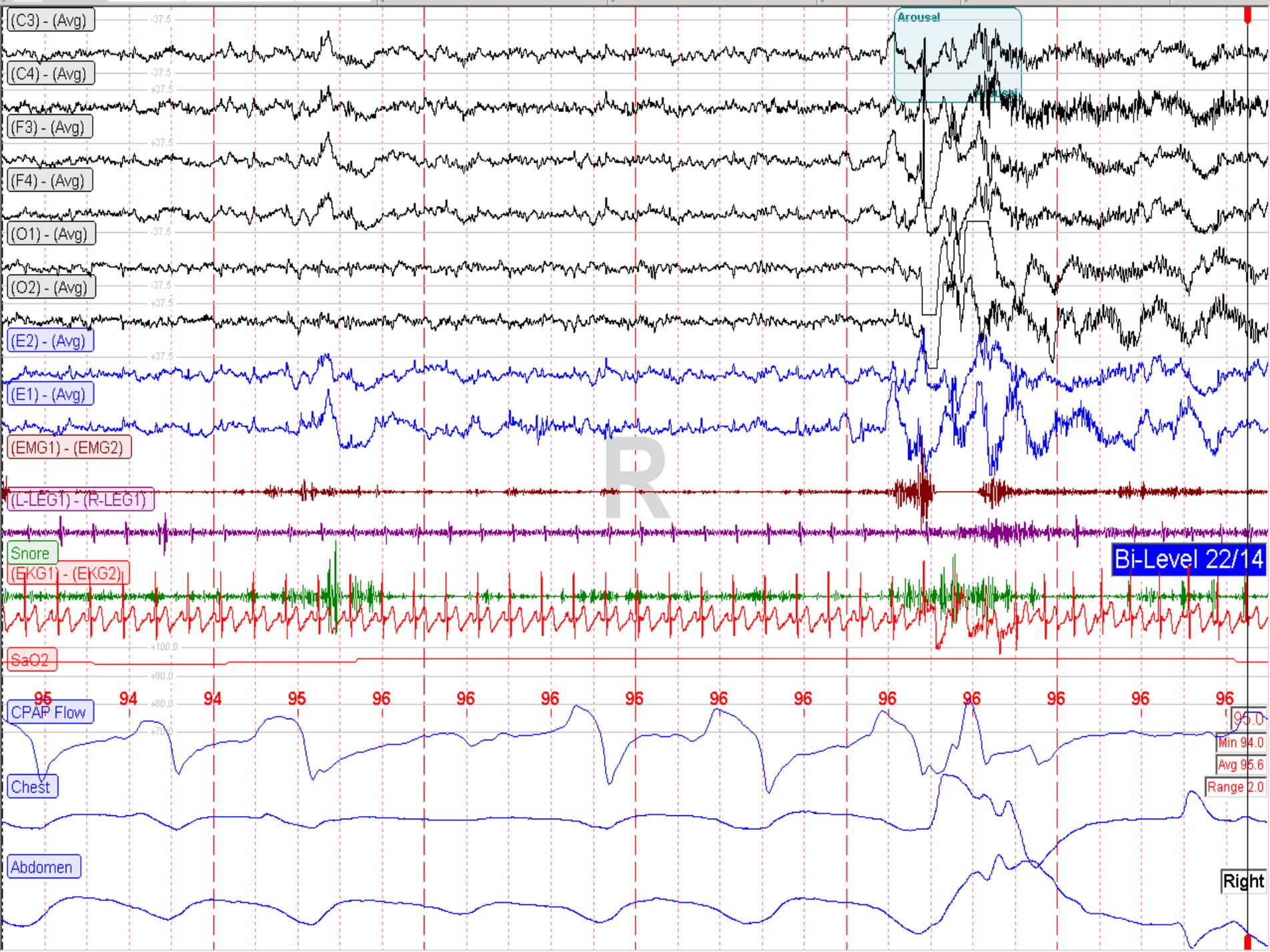
Rule #4

- ▣ Arousals in NREM sleep may occur without concurrent increases in submental EMG amplitude.



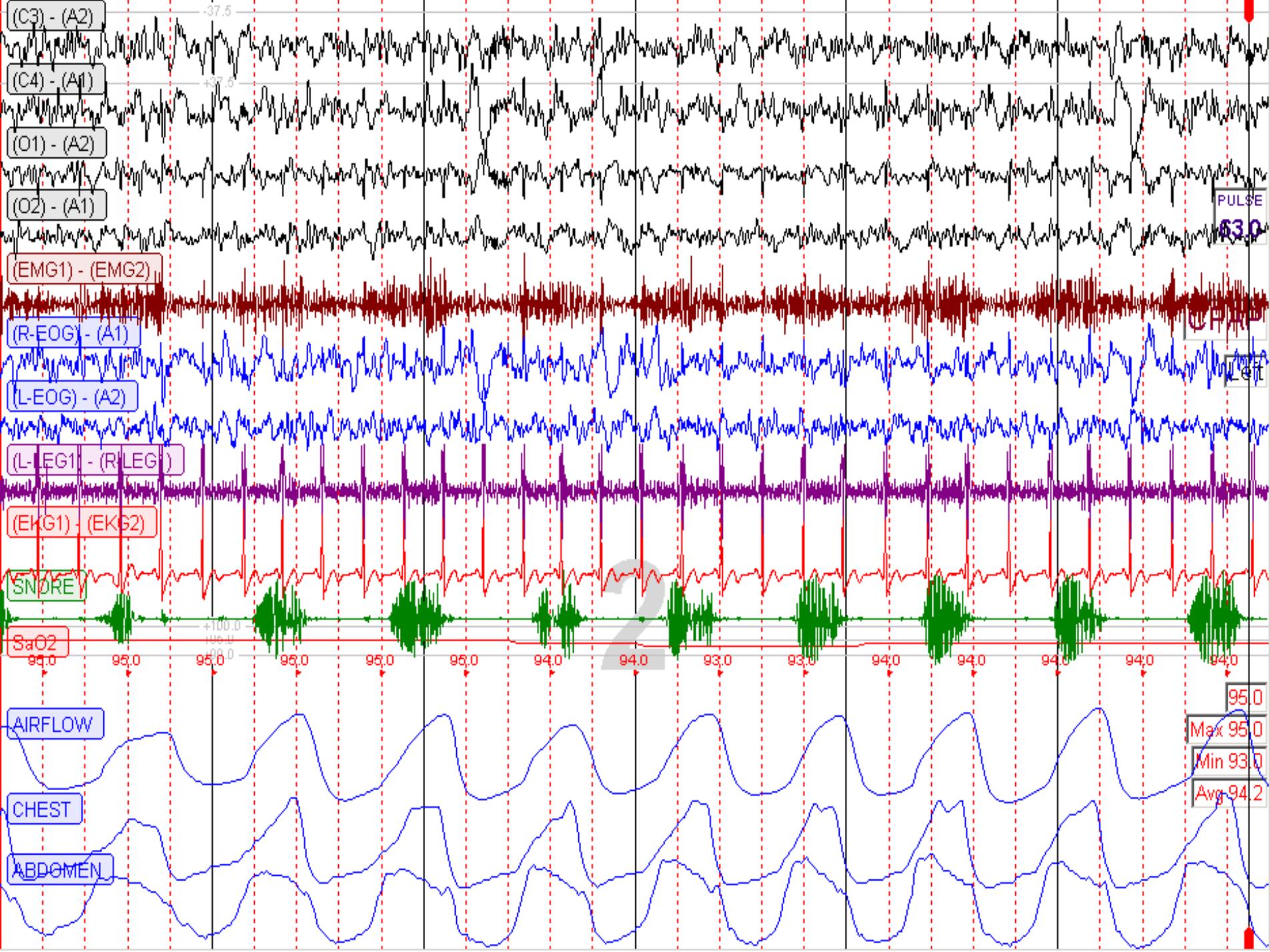
Rule #5

- ▣ Arousals are scored in REM sleep only when accompanied by concurrent increases in submental EMG amplitude.



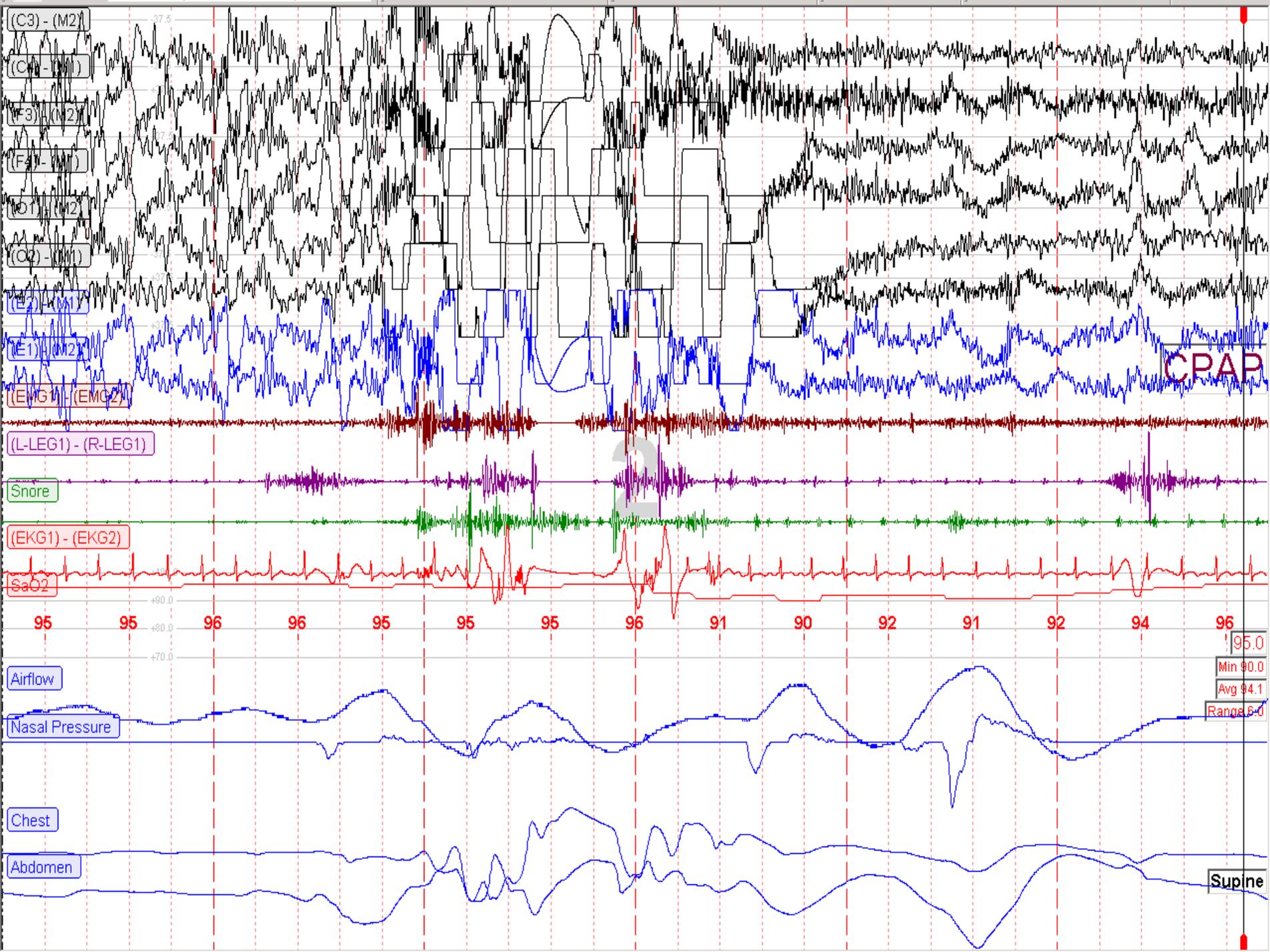
Rule #6

- ▣ Arousals cannot be scored based on changes in submental EMG amplitude alone.



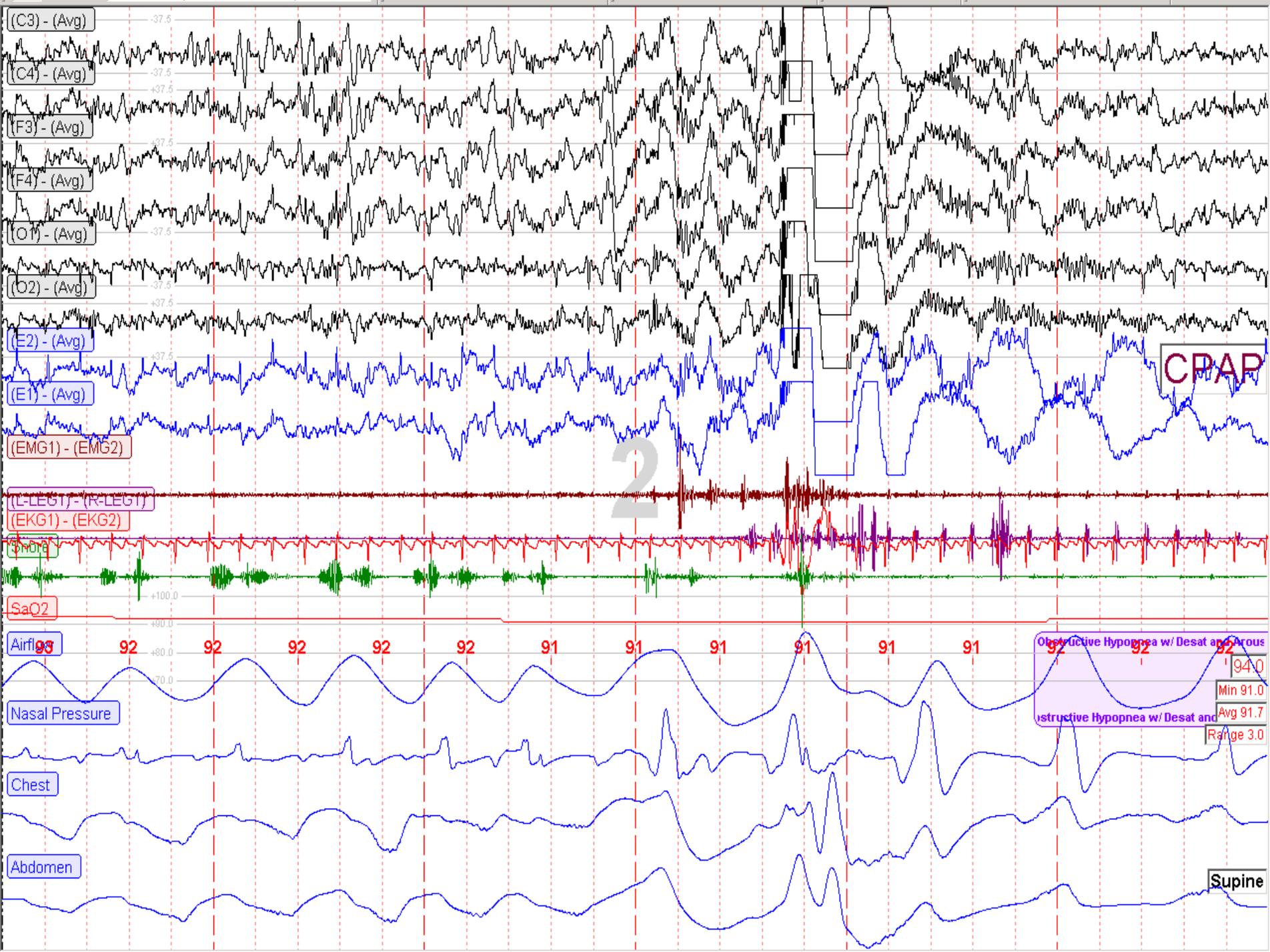
Rule #7

- ▣ Artifacts, K-complexes or Delta waves are not scored as arousals unless accompanied by an EEG frequency shift in at least one derivation.
- ▣ If such activity precedes an EEG frequency shift, it is not included in reaching the 3-second duration criteria.



Rule #8

- ▣ The occurrence of pen blocking artifact should be considered an arousal only if an EEG arousal pattern is contiguous.
- ▣ The pen blocking event can be included in reaching duration criteria.



Rule #9

- ▣ Non-current, but contiguous EEG and EMG changes, which were individually less than 3 seconds but together greater than 3 seconds in duration are not scored as arousals.

C9-A2

O1-A2

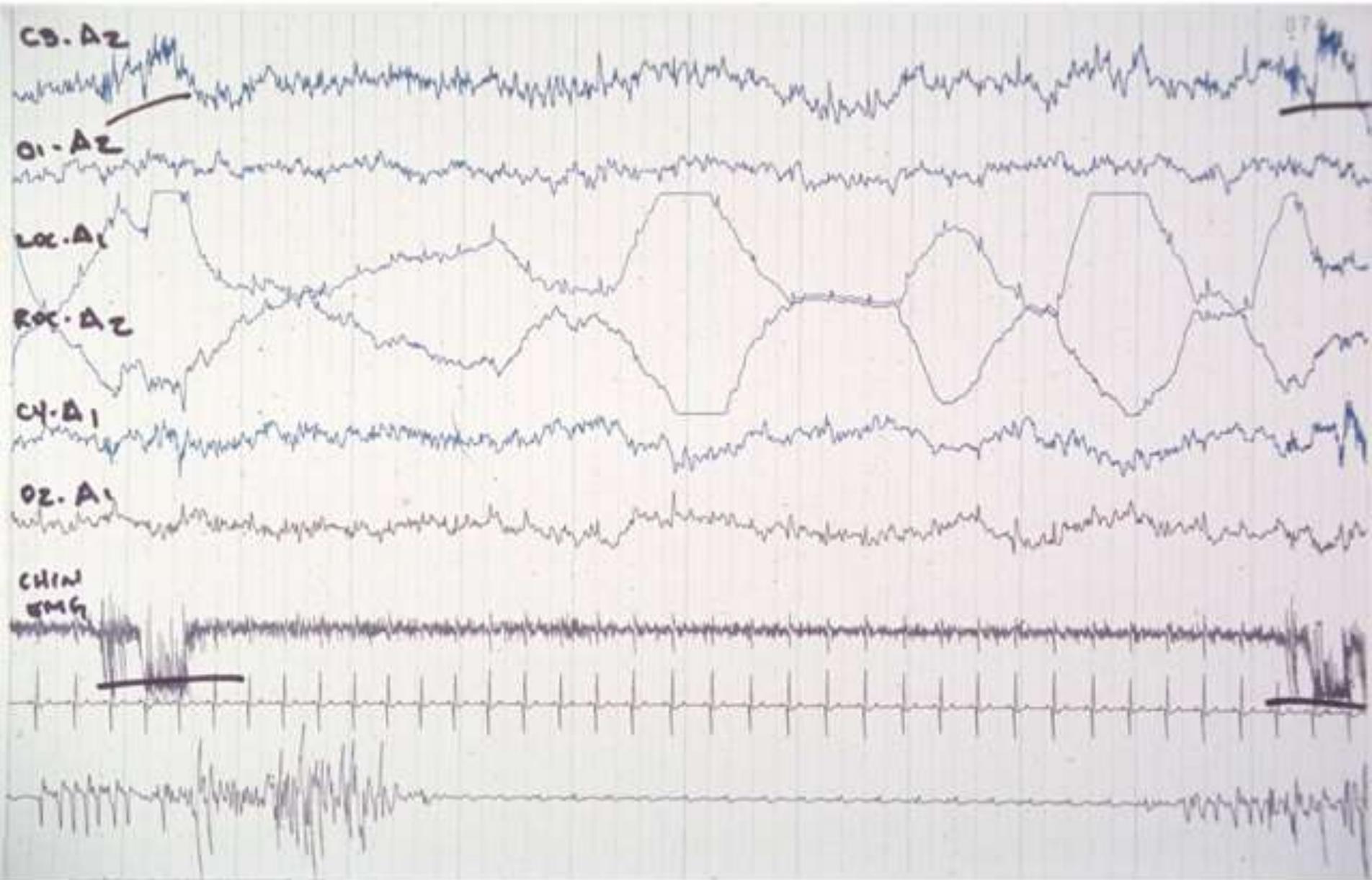
LOC-A1

R9C-A2

C4-A1

O2-A1

CHIN
EMG



C4-A1

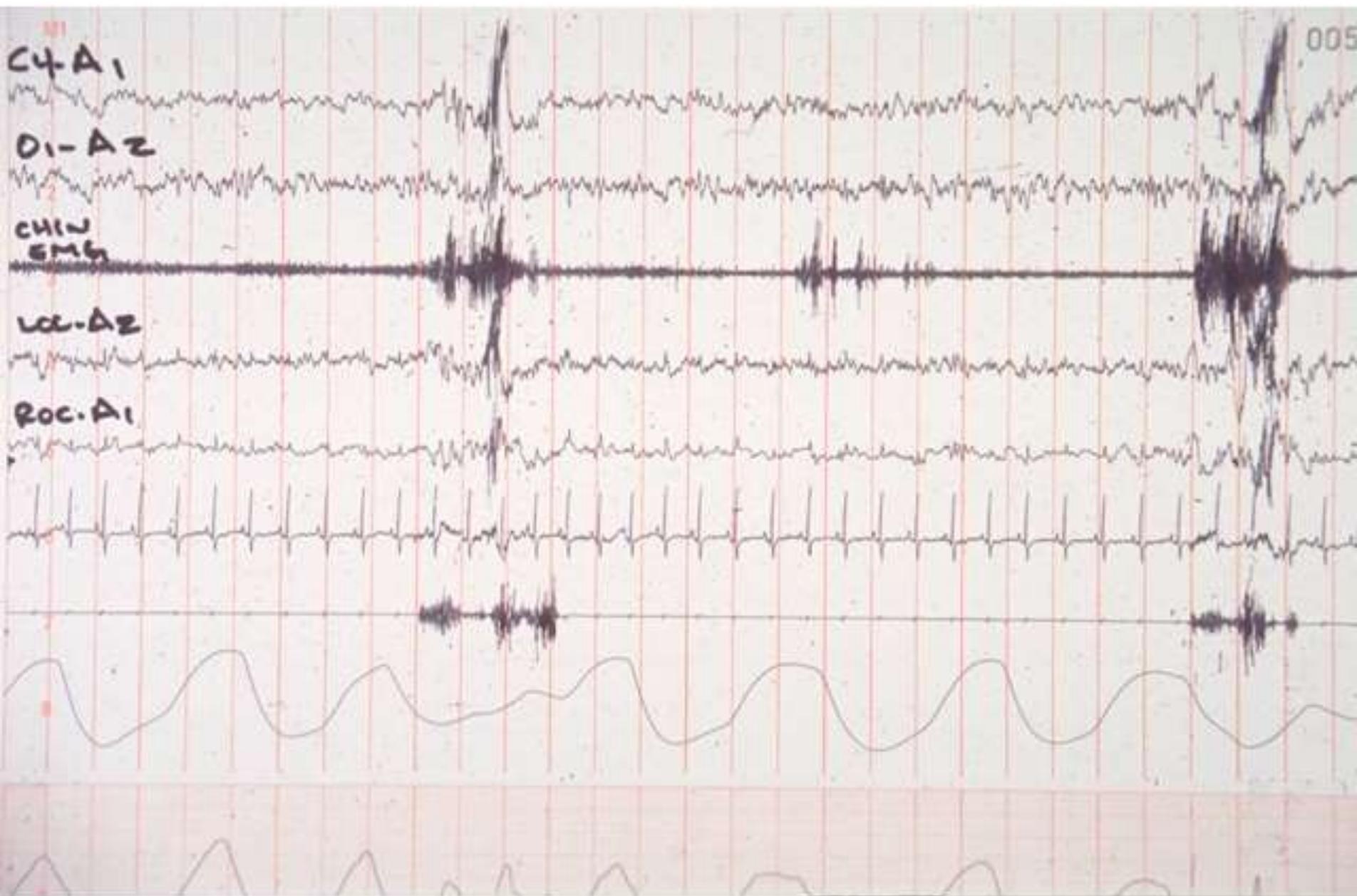
O1-A2

CHIN
EMG

LOC-A2

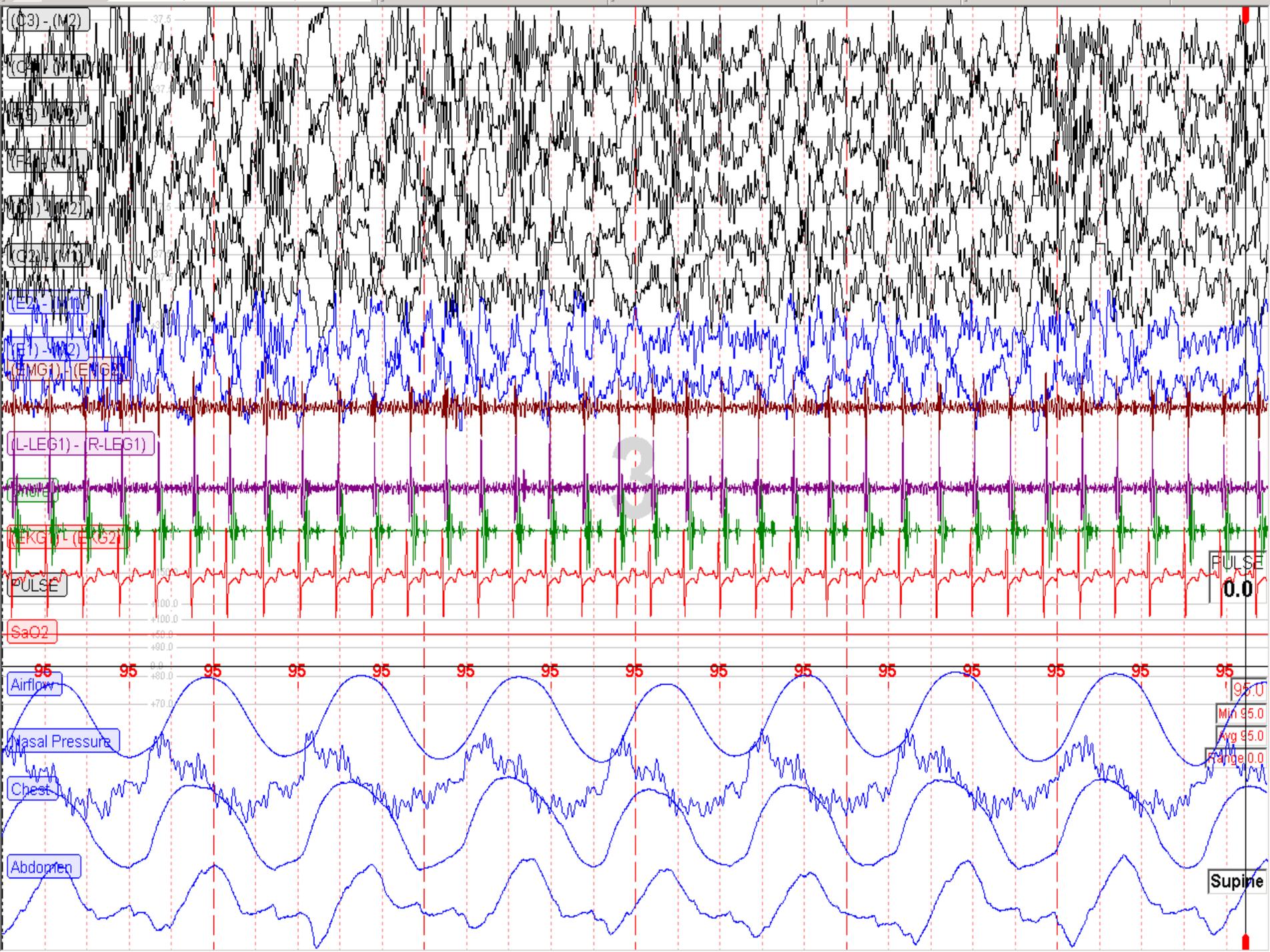
ROC-A1

005



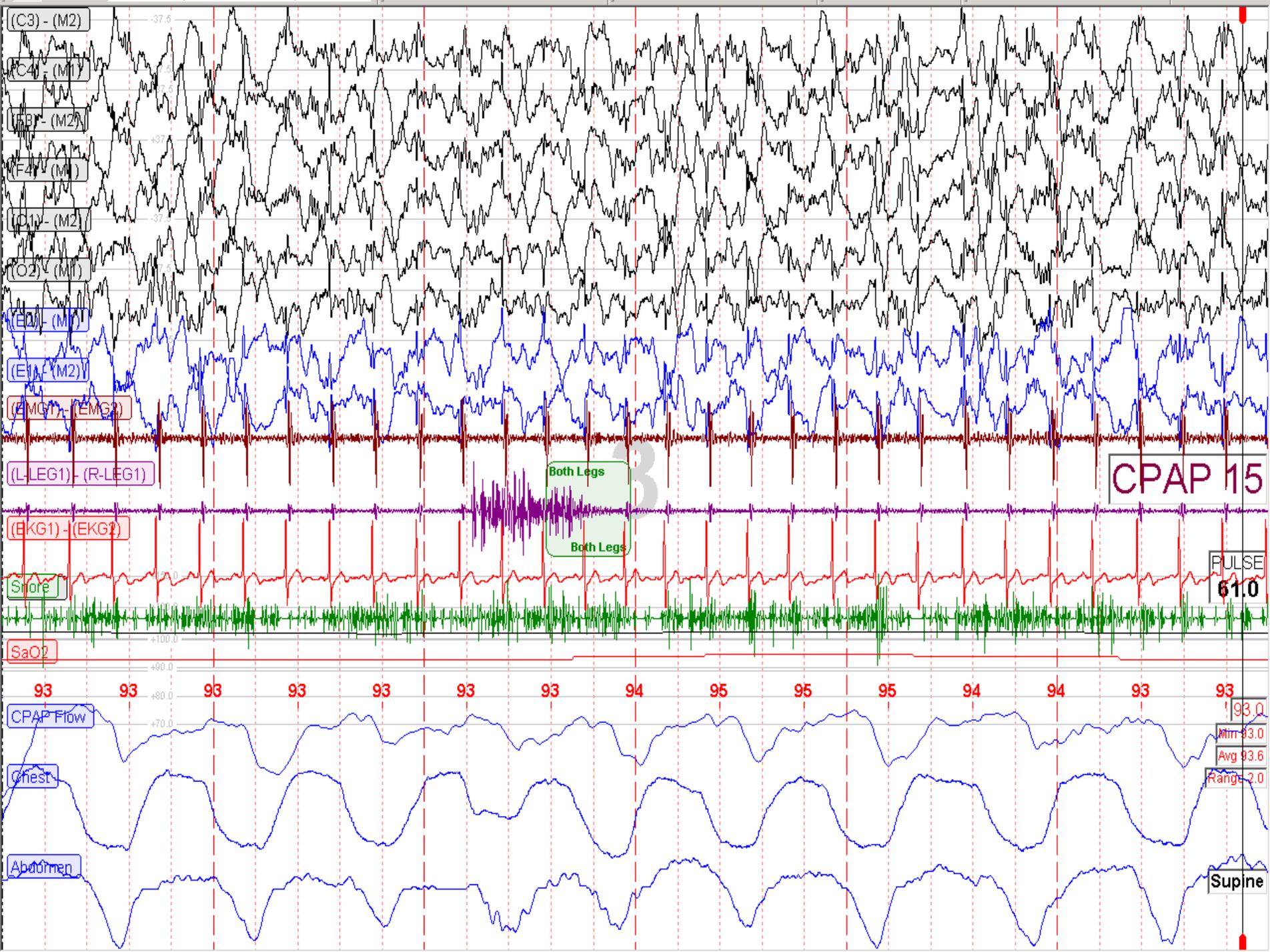
Rule #10

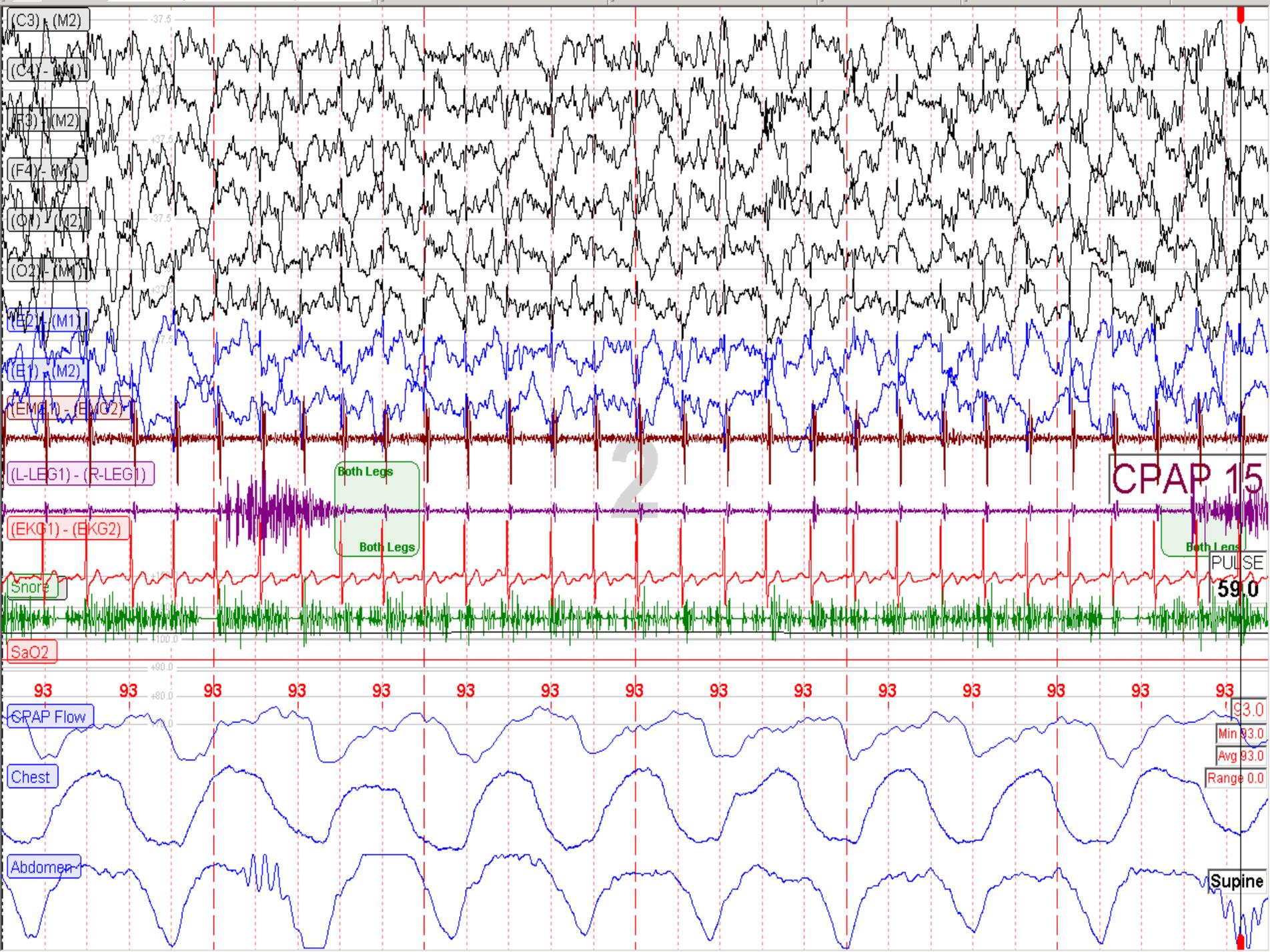
- ▣ Intrusion of alpha activity of less than 3 seconds duration into NREM sleep at a rate greater than 1 burst per 10 seconds is not scored as an EEG arousal.
- ▣ Three seconds of alpha sleep is not scored as an arousal unless a 10 second episode of alpha-free sleep precedes.



Rule #11

- ▣ Transitions from one stage of sleep to another are not sufficient of themselves to be scored as EEG arousals unless they meet the criteria indicated above





The Hypnogram Says It All



Citations

The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications Version 2.1

1. Iber C, Ancoli-Israel S, Chesson A, and Quan SF for the American Academy of Sleep Medicine. The 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. Berry RB, Brooks R, Gamaldo CE, Harding SM, Marcus CL, Vaughn BV and Tangredi MM for the American Academy of Sleep Medicine. The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical Specifications, Version 2.0. www.aasmnet.org, Darien, Illinois: American Academy of Sleep Medicine, 2012.
3. Rechtschaffen A, Kales A, eds. A manual of standardized terminology, techniques and scoring system for sleep stages of human subjects. Los Angeles, CA: BI/BR, 1968.

UPDATES FOR PEDS

Visual Rules for Children



▣ No change in age description

- Rules can be used to score sleep and wake in children 2 months post-term

▣ No change in terminology for staging

▣ Technical specifications remain the same as adult

- Notes related to the need to reduce the distance for EOG and chin EMG electrodes in children and infants with small heads

- ▣ Change in notes related to when sleep spindles may be seen in children and added a description of how spindles occur during this age.
- ▣ “ Sleep spindles may be seen by age 4-6 weeks post-term and are present in all normal infants by age 2-3 months post-term. At this age the spindles are asynchronous between the hemispheres but become more synchronous over the first year of life.²”

Pediatric Scoring Rules Scenarios are Unchanged

If all epochs of NREM sleep contain no recognizable sleep spindles, K complexes or high-amplitude 0.5-2 Hz slow wave activity, score all epochs of NREM sleep as stage N (NREM).²

If some epochs of NREM sleep contain sleep spindles or K complexes, score those as stage N2 (NREM 2). If in the remaining NREM epochs, there is no slow wave activity comprising more than 20% of the duration of epochs, score as stage N (NREM).²

If some epochs of NREM sleep contain greater than 20% slow wave activity, score these as stage N3 (NREM 3). If in the remaining NREM epochs, there are no K complexes or spindles then score as stage N (NREM).²

If NREM is sufficiently developed that some epochs contain sleep spindles or K complexes and other epochs contain sufficient amounts of slow wave activity, then score NREM sleep in this infant as either stage N1, N2 or N3 as in an older child or adult.²

STAGE W in Pediatrics

Definitions for scoring Stage W are unchanged and include:

- Alpha Rhythm
- Eye Blinks
- Reading Eye Movements
- Rapid Eye Movements
- Dominant Posterior Rhythm

The term "posterior dominant rhythm" replaces the term "alpha rhythm" when scoring wakefulness and NREM stages in children.

Epochs are scored as stage W when more than 50% of the epoch has either reactive alpha or age-appropriate posterior dominant rhythm over the occipital region.

Epochs with no discernible reactive alpha or no age-appropriate posterior dominant rhythm should be scored as stage W if ANY of the following are present:

- Eye blinks at a frequency of 0.5-2 Hz
- Reading eye movements
- Irregular, conjugate rapid eye movements associated with normal or high chin muscle tone

Stage N1 in Pediatrics

Definitions for scoring Stage W are unchanged and include:

- Slow eye movements
- Low-amplitude, mixed-frequency activity
- Vertex sharp waves
- Sleep onset
- Rhythmic anterior theta activity
- Hypnagogic hypersynchrony

If posterior dominant rhythm is present and attenuated or replaced by low-amplitude, mixed-frequency activity >50% of the epoch, score the epoch as **stage N1**.

*If the posterior dominant rhythm, is not present score **stage N1** when any of the following occur:*

- *Activity in the range of 4-7 Hz with slowing of background frequencies by $\geq 1-2$ Hz from those of stage W*
- *Slow eye movements*
- *Vertex sharp waves*
- *Rhythmic anterior theta activity*
- *Hypnagogic hypersynchrony*
- *Diffuse or occipital-predominant, high-amplitude, rhythmic 3-5 Hz activity²*

STAGE N2 and stage n3 in Pediatrics

Score stages N2 and N3 in children utilizing the same rules as adults

Stage R in pediatrics

Score stage R in children utilizing the same rules as adults

The continuous, low-amplitude, mixed-frequency EEG activity of stage R in infants and children resembles adults although the dominant frequencies increase with age: approximately 3 Hz activity at 7 weeks post-term, 4-5 Hz activity with bursts of sawtooth waves at 5 months, 4-6 Hz at 9 months, and prolonged runs or bursts of notched 5-7 Hz theta activity at 1-5 years of age may populate the background activity. By 5-10 years of age, the low-amplitude, mixed-frequency activity in stage R is similar to that of adults.²