Military Wearable-Derived Readiness Scoring Suite (v1) 18 High-Value Scores Using Your Current 30 Apple Watch Metrics

Generated: 2026-01-13 | Intended for on-device computation (privacy-first) and defense readiness screening/monitoring.

Metrics available (30)

• HEART_RATE, RESTING_HEART_RATE, WALKING_HEART_RATE, HRV_SDNN, HRV_RMSSD, BLOOD_OXYGEN, RESPIRATORY_RATE, PERIPHERAL_PERFUSION_INDEX

• STEPS, DISTANCE_WALKING_RUNNING, DISTANCE_CYCLING, DISTANCE_SWIMMING, FLIGHTS_CLIMBED, ACTIVE_ENERGY_BURNED, EXERCISE_TIME

• SLEEP_ASLEEP, SLEEP_DEEP, SLEEP_REM, SLEEP_LIGHT, SLEEP_AWAKE, SLEEP_AWAKE_IN_BED, SLEEP_IN_BED, SLEEP_SESSION

• ELECTRODERMAL_ACTIVITY, MINDFULNESS

• HIGH_HEART_RATE_EVENT, LOW_HEART_RATE_EVENT, IRREGULAR_HEART_RATE_EVENT

• BODY_TEMPERATURE

• WORKOUT

Foundation: baselines, normalization, and reliability gates

• **Why:** Wearable signals are person-specific. All scores below depend on personal baselines and robust normalization.

• **Baseline window:** Maintain a rolling 14-day baseline for each metric using median (m) and median absolute deviation (MAD).

• **Robust z-score:** $z = (x - m) / (1.4826 \cdot MAD + \varepsilon)$. Clamp z to [–4, +4] to limit outliers.

• **Acute vs chronic load:** For training load-derived scores, compute EWMA(7d) as *acute* and EWMA(28d) as *chronic*.

• **Data sufficiency gate:** If a metric has < 3 samples/day (or missing nights for sleep), reduce its weight and increase uncertainty.

• **Time alignment:** Daily scores update once per day (after sleep) + optional intraday refresh (e.g., HR, SpO■, EDA).

1. Overall Readiness Score (0–100)

Purpose: Single roll-up indicator for 'go / caution / stop' based on recovery, sleep, cardio-respiratory stability, and recent load.

Inputs: HRV_RMSSD/SDNN, RESTING_HEART_RATE, SLEEP_* staging, BODY_TEMPERATURE, RESPIRATORY_RATE, BLOOD_OXYGEN, ELECTRODERMAL_ACTIVITY, ACTIVE_ENERGY_BURNED/EXERCISE_TIME, HEART EVENTS.

Computation:

• Compute component subscores (each 0–100): Recovery (Score #2), Sleep Index (#5), Cardio-Resp Stability (#9), Load/Fatigue (#3), and Safety Flags (#14).

• Readiness = 0.30·Recovery + 0.25·Sleep + 0.20·CardioResp + 0.20·(100–Fatigue) + 0.05·(100−SafetyPenalty).

• Clamp to [0,100]. If SafetyPenalty ≥ 60 (e.g., new irregular rhythm event + symptoms), force Readiness ≤ 39 (STOP).

Operational notes:

• Defense-friendly interpretation: 80–100 GO (full duty/training), 60–79 CAUTION (modified load), 40–59 LIMITED (medical review / rest), <40 STOP.

• Always show confidence (High/Med/Low) based on data sufficiency gate.

2. Recovery Score (0–100)

Purpose: Measures autonomic recovery and physiologic strain vs personal baseline.

Inputs: HRV_RMSSD, HRV_SDNN, RESTING_HEART_RATE, BODY_TEMPERATURE, ELECTRODERMAL_ACTIVITY, SLEEP_ASLEEP, SLEEP_DEEP.

Computation:

• HRV component: HRV_z = 0.6·z(RMSSD) + 0.4·z(SDNN). Map to 0–100: HRV_score = 50 + 12.5·HRV_z (clamp 0–100).

• RHR component: RHR_score = 50 − 12.5·z(RESTING_HEART_RATE) (higher RHR than baseline reduces recovery).

• Temp component: Temp_score = 50 − 20·|z(BODY_TEMPERATURE)| (penalize deviation both directions).

• Stress component: Stress_score = 50 − 12.5·z(EDA_daily) where EDA_daily is nightly median or daily mean.

• Sleep recovery boost: SleepBoost = 10·min(1, SLEEP_DEEP / (0.18·SLEEP_ASLEEP + ε)).

• Recovery = clamp(0,100, 0.35·HRV_score + 0.25·RHR_score + 0.20·Temp_score + 0.10·Stress_score + 0.10·(50+SleepBoost)).

Operational notes:

• Use overnight HRV if available; if only sparse HRV, reduce HRV weight and increase RHR weight.

• EDA varies by device/app; treat as optional (weight→0 if missing).

3. Fatigue Index (0–100)

Purpose: How 'loaded' the body is from recent physical work relative to its longer-term capacity (training stress + recovery suppression).

Inputs: ACTIVE_ENERGY_BURNED, EXERCISE_TIME, WORKOUT intensity proxy (HR during workouts), HRV_RMSSD, RESTING_HEART_RATE, SLEEP_ASLEEP.

Computation:

• Training Load (TL): compute TRIMP-style load per workout using heart-rate reserve (HRR) zones: TRIMP = duration_min · ΔHR · y, where ΔHR=(HR_ex–HR_rest)/(HR_max–HR_rest). Use y = 0.64·e^(1.92·ΔHR) (men) or 0.86·e^(1.67·ΔHR) (women) if sex known; else y=0.75·e^(1.8·ΔHR). [R1]

• AcuteLoad = EWMA_7d(TRIMP or ActiveEnergy+ExerciseTime proxy). ChronicLoad = EWMA_28d(...).

• ACWR = AcuteLoad / (ChronicLoad + ε). Convert to strain score: LoadScore = 100·sigmoid((ACWR−1.0)/0.15), where sigmoid(u)=1/(1+e^(−u)).

• Recovery suppression: Supp = 50·max(0, −z(RMSSD)) + 30·max(0, z(RHR)) + 20·max(0, sleepDebt), where sleepDebt = max(0, (targetSleep−SLEEP_ASLEEP)/targetSleep).

• Fatigue = clamp(0,100, 0.6·LoadScore + 0.4·min(100, Supp)).

Operational notes:

• ACWR is widely used in sports workload monitoring; treat as a risk indicator, not a diagnosis. [R4]

• If HR_max unknown, estimate HR_max = 208 − 0.7·age (or user-provided).

4. Endurance Capacity Score (0–100)

Purpose: Tracks aerobic work capacity and sustained activity ability (useful for rucks, long missions, PT).

Inputs: DISTANCE_WALKING_RUNNING, DISTANCE_CYCLING, DISTANCE_SWIMMING, EXERCISE_TIME, WALKING_HEART_RATE, RESTING_HEART_RATE, WORKOUT.

Computation:

• WeeklyVolume = 7-day sum of distance (convert cycling/swim to 'run-equivalent' using MET ratios if desired; else keep separate).

• Intensity proxy: Int = 50 − 12.5·z(WALKING_HEART_RATE) (lower HR for same walking load implies better economy).

• Time component: TimeScore = percentile(EXERCISE_TIME_7d vs personal 90-day history) scaled 0–100.

• Endurance = clamp(0,100, 0.45·percentile(WeeklyVolume) + 0.25·TimeScore + 0.30·Int).

Operational notes:

• This score improves as the same movement load requires less cardiovascular cost (walking HR).

• Use 90-day personal history for percentiles once available; before that use population defaults carefully.

5. Sleep Index (0–100)

Purpose: Nightly sleep quality/quantity for cognitive + physical performance.

Inputs: SLEEP_ASLEEP, SLEEP_IN_BED, SLEEP_DEEP, SLEEP_REM, SLEEP_AWAKE, SLEEP_AWAKE_IN_BED, SLEEP_LIGHT, BODY_TEMPERATURE, RESTING_HEART_RATE.

Computation:

• SleepDurationScore = 100·min(1, SLEEP_ASLEEP / targetSleep) where targetSleep default 7.5h (450 min) or personalized.

• Efficiency = SLEEP_ASLEEP / (SLEEP_IN_BED + ε). EfficiencyScore = 100·clamp(0,1,(Efficiency−0.75)/0.20).

• DeepFrac = SLEEP_DEEP/(SLEEP_ASLEEP+ε); REMFrac = SLEEP_REM/(SLEEP_ASLEEP+ε). StageScore = 50·clamp(0,1,DeepFrac/0.18) + 50·clamp(0,1,REMFrac/0.22). (Typical adult ranges vary; treat as soft targets.) [R5]

• FragmentationScore = 100 − 100·clamp(0,1,(SLEEP_AWAKE/(SLEEP_ASLEEP+ε) − 0.05)/0.10).

• PhysioPenalty = 15·max(0,z(RESTING_HEART_RATE)) + 15·|z(BODY_TEMPERATURE)|.

• SleepIndex = clamp(0,100, 0.30·SleepDurationScore + 0.20·EfficiencyScore + 0.20·StageScore + 0.20·FragmentationScore − PhysioPenalty).

Operational notes:

• For operational use, keep sleep targets role-dependent (shift work, deployment).

• Apple Watch sleep stages are estimates; reliability improves with consistent wear.

6. Cardiovascular Fitness Score (0–100)

Purpose: Approximates aerobic fitness (field-ready) using available wearable indicators; optionally include VO■max when available.

Inputs: WALKING_HEART_RATE, RESTING_HEART_RATE, HEART_RATE during workouts, WORKOUT, (optional VO2 max from Apple Cardio Fitness if present).

Computation:

• If VO■max is available from Apple Health (HKQuantityTypeIdentifierVO2Max), use it as anchor: Fit = percentile(VO2max by age/sex) mapped 0–100. [R6]

• Otherwise compute economy index: Econ = z(RESTING_HEART_RATE) + 0.8·z(WALKING_HEART_RATE). Lower is better.

• Add exertion response: During steady aerobic workouts, compute HR_slope = ΔHR/Δtime; lower slope implies better conditioning.

• CardioFit = clamp(0,100, 70 − 10·Econ − 5·z(HR_slope)).

Operational notes:

• Mark as 'estimated' unless VO■max present.

• Do not interpret as medical fitness certification; use for trend + screening.

7. Stress Load Score (0–100)

Purpose: Captures sympathetic activation and psychological strain that can degrade readiness and decision-making.

Inputs: ELECTRODERMAL_ACTIVITY, HEART_RATE, HRV_RMSSD, MINDFULNESS.

Computation:

• EDA_z = z(EDA_daily). HR_z = z(median daytime HEART_RATE). HRV_z = z(RMSSD).

• StressRaw = 0.5·max(0,EDA_z) + 0.3·max(0,HR_z) + 0.2·max(0,–HRV_z).

• Mindfulness credit: Mind = min(1, MINDFULNESS_minutes / 10).

• StressScore = clamp(0,100, 50 + 25·StressRaw − 10·Mind). (Higher = more stress load).

Operational notes:

• If EDA missing, redistribute weight to HR and HRV.

• Use in tandem with SleepIndex and Recovery; chronic high stress + poor sleep is a red flag.

8. Injury Risk Indicator (0–100)

Purpose: Operational risk heuristic combining workload spikes, fatigue, sleep deficit, and high-impact volume.

Inputs: Fatigue Index (#3), SLEEP_ASLEEP, STEPS, DISTANCE_WALKING_RUNNING, FLIGHTS_CLIMBED, WORKOUT.

Computation:

• Work spike: Spike = clamp(0,2, ACWR) from Score #3.

• ImpactVolume = percentile((STEPS_7d + 120·FLIGHTS_CLIMBED_7d)) mapped 0–100.

• SleepDebt = max(0,(targetSleep−SLEEP_ASLEEP)/targetSleep).

• Risk = clamp(0,100, 40·sigmoid((Spike−1.2)/0.1) + 30·(Fatigue/100) + 20·SleepDebt + 10·(ImpactVolume/100)).

Operational notes:

• Use as 'risk to manage' (adjust training) not 'predict injury with certainty'.

• Consider mission type and load carriage; add ruck weight later if available.

9. Cardio-Respiratory Stability Score (0–100)

Purpose: Early warning for illness/altitude/overreaching via combined RR, SpO■, perfusion, and HR changes.

Inputs: RESPIRATORY_RATE, BLOOD_OXYGEN, PERIPHERAL_PERFUSION_INDEX, RESTING_HEART_RATE, BODY_TEMPERATURE.

Computation:

• RR_score = 50 − 15·z(RESPIRATORY_RATE).

• SpO2_score = 50 + 20·z(BLOOD_OXYGEN) (lower-than-baseline SpO■ penalizes).

• PPI_score = 50 + 10·z(PERIPHERAL_PERFUSION_INDEX).

• HR_temp_pen = 10·max(0,z(RHR)) + 10·|z(Temp)|.

• CardioResp = clamp(0,100, 0.25·RR_score + 0.35·SpO2_score + 0.20·PPI_score + 0.20·(100−HR_temp_pen)).

Operational notes:

• Strong for detecting 'something is off' even when the person feels fine.

• Make altitude mode optional (deployment at elevation changes baseline).

10. Heat / Illness Risk Flag (0–100)

Purpose: Flags physiologic deviation consistent with infection, heat stress, or inflammation.

Inputs: BODY_TEMPERATURE, RESTING_HEART_RATE, RESPIRATORY_RATE, HRV_RMSSD, SLEEP_ASLEEP.

Computation:

• TempDev = |z(BODY_TEMPERATURE)|; RHR_up = max(0,z(RHR)); RR_up=max(0,z(RR)); HRV_down=max(0,−z(RMSSD)).

• IllnessRaw = 0.40·TempDev + 0.25·RHR_up + 0.20·RR_up + 0.15·HRV_down.

• SleepPenalty = max(0,(targetSleep−SLEEP_ASLEEP)/targetSleep).

• IllnessRisk = clamp(0,100, 30 + 35·IllnessRaw + 20·SleepPenalty).

Operational notes:

• If IllnessRisk > 70: suggest temp re-check + symptom checklist + reduce training + consider medical review.

• Avoid false alarms by requiring deviation ≥ 2 consecutive days unless extreme.

11. Daily Activity Score (0–100)

Purpose: General movement and non-exercise activity (useful for sedentary drift in garrison/office).

Inputs: STEPS, DISTANCE_WALKING_RUNNING, FLIGHTS_CLIMBED, ACTIVE_ENERGY_BURNED.

Computation:

• StepsScore = clamp(0,100, 100·min(1, STEPS/10000)).

• DistanceScore = clamp(0,100, 100·min(1, DISTANCE_WALKING_RUNNING/8000m)).

• FloorsScore = clamp(0,100, 100·min(1, FLIGHTS_CLIMBED/20)).

• EnergyScore = percentile(ACTIVE_ENERGY_BURNED) mapped 0–100.

• Activity = 0.35·StepsScore + 0.25·DistanceScore + 0.15·FloorsScore + 0.25·EnergyScore.

Operational notes:

• Targets should be role- and mission-dependent; keep defaults conservative.

12. Work Capacity Score (0–100)

Purpose: How much high-quality training work the person can tolerate without degradation (readiness to train hard).

Inputs: EXERCISE_TIME, ACTIVE_ENERGY_BURNED, WORKOUT, Recovery Score (#2), Sleep Index (#5).

Computation:

• CapacityBase = 0.5·Recovery + 0.5·SleepIndex.

• WorkRecent = percentile(EXERCISE_TIME_14d) mapped 0–100.

• Capacity = clamp(0,100, 0.7·CapacityBase + 0.3·WorkRecent).

Operational notes:

• Good for planning PT intensity and progressive overload without breaking people.

13. Altitude / Oxygenation Score (0–100)

Purpose: Tracks oxygen delivery and acclimatization (SpO■ + perfusion + RR).

Inputs: BLOOD_OXYGEN, PERIPHERAL_PERFUSION_INDEX, RESPIRATORY_RATE.

Computation:

• O2drop = max(0, −z(SpO2)); PerfDrop=max(0, −z(PPI)); RRrise=max(0, z(RR)).

• AltitudeRisk = 0.5·O2drop + 0.3·PerfDrop + 0.2·RRrise.

• AltitudeScore = clamp(0,100, 85 − 30·AltitudeRisk).

Operational notes:

• Enable when operating at altitude; otherwise interpret mainly as respiratory stability.

14. Cardiac Safety Penalty (0–100)

Purpose: Safety overlay for abnormal rhythm / rate events; reduces Readiness even if other scores look good.

Inputs: HIGH_HEART_RATE_EVENT, LOW_HEART_RATE_EVENT, IRREGULAR_HEART_RATE_EVENT, HEART_RATE, RESTING_HEART_RATE.

Computation:

• EventCount = HighEvents_24h + LowEvents_24h + 2·IrregularEvents_24h.

• Penalty = clamp(0,100, 20·min(5, EventCount) + 10·max(0,z(RHR)) + 10·max(0,z(HR_restingEpisodes))).

• If any new Irregular event: Penalty ≥ 40 until clinician review or repeated normal days.

Operational notes:

• Treat as triage: it is not a diagnosis, but defense programs often require conservative action on arrhythmia signals.

15. Sleep Debt Score (0–100)

Purpose: Quantifies cumulative sleep loss over time (mission-critical).

Inputs: SLEEP_ASLEEP (daily), Sleep target.

Computation:

• DailyDebt = max(0, targetSleep − SLEEP_ASLEEP) in minutes.

• Debt7 = sum(DailyDebt over last 7 days). Debt28 = sum over 28 days.

• DebtScore = clamp(0,100, 100 − 100·min(1, Debt7/(7·90min))). (Full penalty when averaging 90 min short/night).

Operational notes:

• Expose both Debt7 and Debt28; chronic debt is common in military ops and has performance impact.

16. Training Readiness Score (0–100)

Purpose: Whether today is appropriate for intense training vs maintenance.

Inputs: Recovery Score (#2), Fatigue Index (#3), Sleep Index (#5), Injury Risk (#8).

Computation:

• TrainReady = clamp(0,100, 0.40·Recovery + 0.25·SleepIndex + 0.20·(100–Fatigue) + 0.15·(100–InjuryRisk)).

Operational notes:

• Translate into prescription: GREEN (≥75) hard training ok; AMBER (55–74) moderate; RED (<55) recovery/skills only.

17. Cognitive Alertness Index (0–100)

Purpose: Proxy for vigilance/decision quality (sleep + autonomic stability + stress management).

Inputs: SLEEP_REM, SLEEP_ASLEEP, SLEEP_AWAKE, HRV_RMSSD, ELECTRODERMAL_ACTIVITY, MINDFULNESS.

Computation:

• REMscore = 100·clamp(0,1, (SLEEP_REM/(SLEEP_ASLEEP+ε))/0.22).

• Fragment = 100 − 100·clamp(0,1,(SLEEP_AWAKE/(SLEEP_ASLEEP+ε) − 0.05)/0.10).

• Autonomic = 50 + 12.5·z(RMSSD) − 12.5·max(0,z(EDA_daily)).

• Mind = min(1, MINDFULNESS_minutes/10).

• Cognitive = clamp(0,100, 0.35·REMscore + 0.25·Fragment + 0.30·Autonomic + 10·Mind).

Operational notes:

• Use as 'risk of degraded alertness' especially for long shifts, driving, flight ops, and guard duty.

18. Thermoregulatory Adaptation Score (0–100)

Purpose: Tracks how stable temperature and cardio-respiratory signals are under training/operational environments.

Inputs: BODY_TEMPERATURE, RESTING_HEART_RATE, RESPIRATORY_RATE, ACTIVE_ENERGY_BURNED, WORKOUT.

Computation:

• During training days, compute TempDelta = bodyTemp_night − baselineTemp.

• Compute CoupledStrain = max(0,z(RHR)) + max(0,z(RR)) + max(0,TempDelta_z).

• AdaptScore = clamp(0,100, 80 − 20·CoupledStrain + 0.2·percentile(ActiveEnergy_7d)).

Operational notes:

• Helpful for heat acclimation tracking; add ambient temp/humidity later for better accuracy.

Implementation checklist (what to store + how to compute)

• Store raw samples locally (encrypted) with timestamps and source; compute daily aggregates (median, mean, p10/p90) per metric.

• Maintain rolling baselines (14d median + MAD) and percentiles (90d) for stable scaling.

• Compute nightly scores after sleep import; compute intraday updates for HR/SpO■/RR/EDA when available.

• Always output: score value, confidence, and primary drivers (top 3 positive/negative contributors) for explainability.

• Add guardrails: if watch not worn (no HR samples), do not compute readiness; show 'insufficient data'.

References

• [R1] TrainingPeaks – 'Training Impulse (TRIMP)' (Banister-style TRIMP equation and intensity factor).

• [R4] Gabbett TJ (2016) – 'The training—injury prevention paradox: should athletes be training smarter and harder?' British Journal of Sports Medicine (ACWR discussion).

• [R5] American Academy of Sleep Medicine – The AASM Manual / Sleep staging definitions (REM/NREM).

• [R6] Apple Developer Documentation – HealthKit VO■ max quantity type (HKQuantityTypeIdentifierVO2Max) / Cardio Fitness.

• [R7] Garmin Support – Body Battery feature (uses HRV-based stress, rest, and sleep to estimate energy reserves).

Source links (for traceability):

R1: https://www.trainingpeaks.com/blog/what-is-trimp/

R4: https://bjsm.bmj.com/content/50/5/273

R5: https://aasm.org/clinical-resources/scoring-manual/

R6: https://developer.apple.com/documentation/healthkit/hkquantitytypeidentifier/vo2max

R7: https://support.garmin.com/en-US/?faq=VOFJAsiXut9K19YOFQYcV8