

# Biometric Data Generation Guide

## Fort Moore Blackhawk Trail Exercise - Physiological Monitoring

### OVERVIEW

This guide provides specific instructions for generating realistic biometric data for the Enhanced Individual Soldier Report System, focusing on body temperature (Column O) and heart rate (Column U - to be added) during the Fort Moore training exercise.

### CSV STRUCTURE MODIFICATIONS

#### Current Structure (20 columns A-T):

|                     |                            |
|---------------------|----------------------------|
| A: callsign         | K: shootercallsign         |
| B: squad            | L: weapon                  |
| C: ip               | M: munition                |
| D: playerid         | N: hitzone                 |
| E: casualtystate    | O: temp (body temperature) |
| F: processedtimegmt | P: rssi                    |
| G: latitude         | Q: mcs                     |
| H: longitude        | R: nexthop                 |
| I: battery          | S: stepcount               |
| J: posture          | T: falldetected            |

#### Required Addition:

- **Column U: heartrate** (Beats per minute - BPM)

### BODY TEMPERATURE SIMULATION (Column O)

#### Baseline Temperature Ranges

|  |
|--|
| Normal Resting: 97.8°F - 99.1°F (36.6°C - 37.3°C)      |
| Light Activity: 98.2°F - 99.8°F (36.8°C - 37.7°C)      |
| Moderate Exertion: 99.0°F - 101.2°F (37.2°C - 38.4°C)  |
| High Stress/Combat: 99.5°F - 102.0°F (37.5°C - 38.9°C) |

#### Temperature Progression by Exercise Phase

##### Phase 1: Preparation & Movement (0700-0830)

#### 0700-0730 (Equipment Prep):

- └─ Base Temperature: 98.0°F - 98.8°F
- └─ Individual Variation:  $\pm 0.3^{\circ}\text{F}$
- └─ Gradual Increase:  $+0.1^{\circ}\text{F}$  per 15 minutes

#### 0730-0815 (Tactical Movement):

- └─ Movement Temperature: 98.5°F - 100.2°F
- └─ Exertion Factor:  $+1.0^{\circ}\text{F}$  -  $2.0^{\circ}\text{F}$  above baseline
- └─ Recovery Periods:  $-0.5^{\circ}\text{F}$  during rest

#### 0815-0830 (Position Establishment):

- └─ Stabilization: 98.8°F - 99.5°F
- └─ Anticipation Stress:  $+0.2^{\circ}\text{F}$  -  $0.5^{\circ}\text{F}$
- └─ Pre-combat Preparation: Slight elevation maintained

### Phase 2: Combat Engagement (0830-0915)

#### 0830-0835 (Initial Contact):

- └─ Stress Response: Immediate  $+0.8^{\circ}\text{F}$  -  $1.5^{\circ}\text{F}$  spike
- └─ Peak Range: 99.8°F - 101.5°F
- └─ Adrenaline Effect: Rapid temperature increase

#### 0835-0900 (Sustained Combat):

- └─ Combat Sustained: 100.0°F - 102.0°F
- └─ Physical Exertion:  $+1.5^{\circ}\text{F}$  -  $2.5^{\circ}\text{F}$  above baseline
- └─ Environmental Heat: Additional  $+0.3^{\circ}\text{F}$  from equipment
- └─ Individual Peaks: 2-3 soldiers may exceed 102°F

#### 0900-0915 (Final Maneuvers):

- └─ Continued Elevation: 99.5°F - 101.8°F
- └─ Fatigue Factor: Slightly decreased from peak
- └─ Tactical Movement: Maintained high levels

### Phase 3: Consolidation (0915-0930)

#### Post-Combat Recovery:

- └─ Gradual Decrease:  $-0.2^{\circ}\text{F}$  per 5-minute interval
- └─ Recovery Range: 99.0°F - 100.5°F
- └─ Return Toward Baseline: Still elevated from exertion

### Individual Soldier Variations

Baseline Metabolic Differences:

- Low Baseline (10% of soldiers): 97.5°F - 98.5°F range
- Normal Baseline (80% of soldiers): 98.0°F - 99.0°F range
- High Baseline (10% of soldiers): 98.5°F - 99.5°F range

Physical Condition Impact:

- High Fitness: Lower temperature increase (+1.0°F max)
- Average Fitness: Standard increase (+1.5°F typical)
- Lower Fitness: Higher increase (+2.0°F+)

Role-Based Variations:

- Squad Leaders: +0.3°F (leadership stress)
- Machine Gunners: +0.5°F (heavy equipment)
- Designated Marksmen: +0.2°F (precision stress)
- Medics: +0.4°F (responsibility stress)

Medical Alert Triggers (Temperature)

Heat Stress Warnings:

- Mild Concern: 101.5°F - 102.0°F (38.6°C - 38.9°C)
- Moderate Alert: 102.1°F - 103.0°F (38.9°C - 39.4°C)
- Severe Alert: >103.0°F (>39.4°C)

Hypothermia Warnings:

- Mild Concern: 95.0°F - 96.5°F (35.0°C - 35.8°C)
- Moderate Alert: 93.0°F - 94.9°F (33.9°C - 34.9°C)
- Severe Alert: <93.0°F (<33.9°C)

Expected Alert Rate:

- 5-8% of soldiers trigger mild temperature alerts
- 1-2% trigger moderate alerts
- 0% severe alerts (training safety)

HEART RATE SIMULATION (Column U - New)

Baseline Heart Rate Ranges by Age/Fitness

Highly Fit Soldiers (60% of unit):

- └ Resting: 50-65 BPM
- └ Light Activity: 70-90 BPM
- └ Moderate Activity: 90-130 BPM
- └ High Intensity: 140-175 BPM
- └ Maximum: 180-195 BPM

Average Fit Soldiers (35% of unit):

- └ Resting: 60-75 BPM
- └ Light Activity: 80-100 BPM
- └ Moderate Activity: 100-140 BPM
- └ High Intensity: 150-180 BPM
- └ Maximum: 185-200 BPM

Lower Fitness Soldiers (5% of unit):

- └ Resting: 70-85 BPM
- └ Light Activity: 90-110 BPM
- └ Moderate Activity: 110-150 BPM
- └ High Intensity: 160-190 BPM
- └ Maximum: 190-205 BPM

## Heart Rate Progression by Exercise Phase

### Phase 1: Preparation & Movement (0700-0830)

#### 0700-0730 (Equipment Preparation):

- └─ Anticipation Elevation: Resting + 10-20 BPM
- └─ BLUEFOR: 70-90 BPM (moderate anticipation)
- └─ OPFOR: 75-95 BPM (aggressive posture)
- └─ Leaders: +5-10 BPM (responsibility stress)

#### 0730-0815 (Tactical Movement):

- └─ Movement Base: 100-140 BPM
- └─ Terrain Difficulty: +10-20 BPM for difficult terrain
- └─ Load Bearing: +5-15 BPM (equipment weight)
- └─ Pace Variations:  $\pm 10$  BPM based on movement speed
- └─ Rest Periods: Drop to 80-100 BPM during halts

#### 0815-0830 (Position Establishment):

- └─ Setup Activity: 90-120 BPM
- └─ Pre-combat Stress: +15-25 BPM anticipation spike
- └─ Final Preparation: 100-130 BPM sustained
- └─ Ready Position: Elevated baseline maintenance

### Phase 2: Combat Engagement (0830-0915)

#### 0830-0835 (Initial Contact):

- └─ Contact Shock: Immediate spike of +40-60 BPM
- └─ BLUEFOR (Initiating): 150-180 BPM
- └─ OPFOR (Receiving): 160-190 BPM (higher surprise factor)
- └─ Peak Response: 2-3 soldiers may exceed 190 BPM

#### 0835-0900 (Sustained Combat):

- └─ Combat Sustained: 140-175 BPM
- └─ Fire and Movement: 160-185 BPM during bounds
- └─ Cover Position: 130-160 BPM (slightly lower in cover)
- └─ Suppressive Fire: 150-180 BPM (weapon operation)
- └─ Fatigue Onset: Gradual 5-10 BPM decrease after 15 min

#### 0900-0915 (Final Maneuvers):

- └─ Continued Combat: 135-170 BPM
- └─ Fatigue Factor: -10-15 BPM from peak levels
- └─ Tactical Movement: 145-175 BPM during movement
- └─ Adrenaline Maintenance: Sustained high levels

### Phase 3: Consolidation (0915-0930)

#### Post-Combat Recovery:

- └─ Immediate Drop: -20-30 BPM in first 2 minutes
- └─ Gradual Recovery: -5-10 BPM per 3-minute interval
- └─ 5-minute mark: 100-130 BPM
- └─ 10-minute mark: 85-110 BPM
- └─ 15-minute mark: 75-95 BPM (approaching elevated baseline)

## Casualty Impact on Heart Rate

#### Wounded Soldiers (WIA):

- └─ Shock Response: +20-40 BPM immediate spike
- └─ Pain Response: Sustained +15-30 BPM elevation
- └─ Blood Loss Simulation: Gradual +10-25 BPM increase
- └─ Medical Treatment: -10-20 BPM during treatment

#### Killed in Action (KIA):

- └─ Final Spike: 180-200+ BPM at moment of casualty
- └─ Data Cessation: No further heart rate data
- └─ Timeline: Heart rate data stops at casualty timestamp

#### Panic State:

- └─ Extreme Elevation: 180-200+ BPM
- └─ Duration: 2-5 minutes of peak levels
- └─ Recovery: Slower return to combat baseline
- └─ Frequency: 1-2 soldiers per exercise

## Medical Alert Triggers (Heart Rate)

#### Bradycardia (Low Heart Rate):

- └─ Mild Alert: 50-59 BPM during activity
- └─ Moderate Alert: 40-49 BPM
- └─ Severe Alert: <40 BPM

#### Tachycardia (High Heart Rate):

- └─ Performance Concern: 190-199 BPM sustained >2 min
- └─ Medical Alert: 200-220 BPM
- └─ Critical Alert: >220 BPM

#### Expected Alert Frequency:

- └─ 3-5% of soldiers trigger heart rate alerts
- └─ Most alerts during peak combat (0835-0900)
- └─ Recovery monitoring in consolidation phase
- └─ No performance penalties for medical alerts

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## BIOMETRIC DATA CORRELATION

### Temperature-Heart Rate Relationships

#### Normal Correlation:

- └─ Every 1°F temperature increase = +8-12 BPM
- └─ Combat stress breaks normal correlation
- └─ Dehydration increases both metrics
- └─ Individual variation:  $\pm 20\%$  from expected correlation

#### Stress Response Pattern:

- └─ Heart rate spikes first (0-30 seconds)
- └─ Temperature follows (2-5 minutes delayed)
- └─ Heart rate recovers faster (5-10 minutes)
- └─ Temperature maintains elevation longer (15-20 minutes)

#### Environmental Factors:

- └─ Ambient temperature: 72°F baseline
- └─ Equipment heat: +1-2°F body temperature
- └─ Direct sunlight: +0.5°F additional
- └─ Physical exertion dominates environmental factors

### Activity-Biometric Correlation

Posture Impact:

- └─ Standing Movement: Highest HR/temp
- └─ Prone Position: Moderate HR, lower temp
- └─ Kneeling: Intermediate levels
- └─ "Down" (casualty): Varies by injury type

Step Count Correlation:

- └─ High step count (>200/15min): +10-20 BPM, +0.5°F
- └─ Moderate activity (50-200 steps): Normal correlation
- └─ Low activity (<50 steps): Baseline levels
- └─ Combat movement: Disconnected correlation due to stress

DATA GENERATION ALGORITHMS

Temperature Generation Logic

python



```
def generate_temperature(soldier, timestamp, phase, activity_level, baseline_temp):  
    # Base calculation  
    temp = baseline_temp  
  
    # Phase-based adjustment  
    if phase == "movement":  
        temp += uniform(0.5, 2.0)  
    elif phase == "combat":  
        temp += uniform(1.5, 2.5)  
    elif phase == "consolidation":  
        temp += uniform(0.2, 1.0)  
  
    # Individual factors  
    temp += soldier.metabolic_factor #  $\pm 0.3^{\circ}F$   
    temp += soldier.fitness_factor   #  $\pm 0.5^{\circ}F$   
    temp += soldier.role_factor      #  $\pm 0.3^{\circ}F$   
  
    # Stress/activity spike  
    if activity_spike:  
        temp += uniform(0.3, 0.8)  
  
    # Temporal smoothing (prevent rapid changes)  
    temp = smooth_transition(previous_temp, temp, max_change=0.2)  
  
    return round(temp, 1)
```

## Heart Rate Generation Logic

python

```
def generate_hearttrate(soldier, timestamp, phase, activity, stress_level):  
    # Base heart rate from fitness profile  
    base_hr = soldier.resting_hr  
  
    # Activity-based calculation  
    if activity == "resting":  
        target_hr = base_hr + uniform(5, 15)  
    elif activity == "light_movement":  
        target_hr = base_hr + uniform(20, 40)  
    elif activity == "tactical_movement":  
        target_hr = base_hr + uniform(40, 80)  
    elif activity == "combat":  
        target_hr = base_hr + uniform(80, 125)  
  
    # Stress multiplier  
    if stress_level == "high":  
        target_hr *= uniform(1.2, 1.4)  
    elif stress_level == "extreme":  
        target_hr *= uniform(1.4, 1.6)  
  
    # Physiological limits  
    max_hr = 220 - soldier.age  
    target_hr = min(target_hr, max_hr)  
  
    # Temporal smoothing  
    hr = smooth_transition(previous_hr, target_hr, max_change=15)  
  
    return round(hr)
```

## Data Quality and Realism

#### Sampling Rate:

- └─ Normal Operations: 30-second intervals
- └─ Combat Phase: 15-second intervals
- └─ Medical Events: 5-second intervals
- └─ Missing Data: <1% realistic sensor failures

#### Physiological Limits:

- └─ Temperature: 95.0°F - 106.0°F absolute bounds
- └─ Heart Rate: 30-250 BPM absolute bounds
- └─ Rate of Change: Realistic physiological transitions
- └─ Correlation Checks: Maintain realistic temp/HR relationships

#### Individual Consistency:

- └─ Each soldier maintains characteristic baseline
- └─ Fitness level affects all calculations
- └─ Medical conditions modify response patterns
- └─ Role-based stress factors remain consistent

## IMPLEMENTATION CHECKLIST

### Pre-Generation Setup

- ☐ Define 60 soldier profiles with baseline biometrics
- ☐ Assign fitness levels and individual variation factors
- ☐ Establish role-based stress modifiers
- ☐ Create timeline with phase transitions

### Generation Process

- ☐ Initialize baseline temperatures and heart rates
- ☐ Apply phase-specific modifications
- ☐ Add individual and role-based variations
- ☐ Implement temporal smoothing algorithms
- ☐ Validate physiological limits and correlations

### Quality Assurance

- ☐ Verify medical alert trigger rates (5-8% of soldiers)
- ☐ Confirm realistic biometric progressions
- ☐ Validate temperature-heart rate correlations
- ☐ Test casualty impact scenarios

☐ Ensure data supports Enhanced Individual Soldier Report System requirements

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**This biometric data generation guide ensures physiologically accurate, tactically relevant data that supports the Enhanced Individual Soldier Report System's primary medical monitoring objectives while maintaining training scenario realism.**