SCARLET | TECH

UNDERSTANDING AND MANAGING WORKPLACE HEAT STRESS

How Heat Stress Harms Workers

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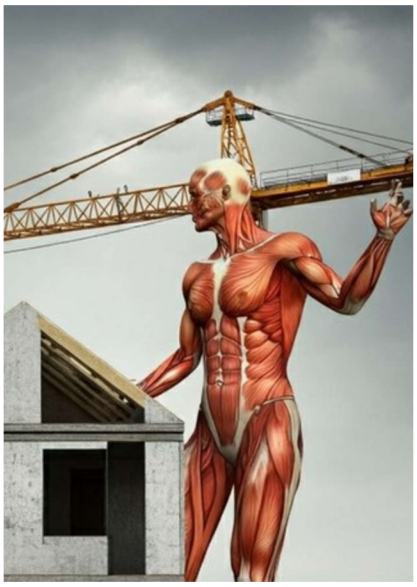
Why Heat is a Workplace Hazard?

The Body Must Maintain 37°C Core Temperature

- Chemical reactions in every cell are optimal at 37°C
  Even ±2°C deviation can be life-threatening
- Muscles are only ~10% efficient
  Over 90% of energy from physical work becomes heat
- The body must continuously dissipate this heat to the environment
- Above 37°C ambient, evaporation of sweat is the ONLY cooling mechanism
- High humidity blocks sweat evaporation — heat cannot escape
- Result: core temperature rises → heat illness → death if unchecked



~10% mechanical efficiency
90% energy → heat

The Heat Balance Equation

HEAT IN
Heat from Work
+ Heat from Environment

+

HEAT OUT
Cooling via Sweat Evaporation
+ Convection + Radiation

Safe Work Possible ✓
When Heat Out ≥ Heat In

How the Body Loses Heat:

EVAPORATION	RADIATION	CONVECTION	CONDUCTION
~60% in hot/humid	~30% at rest	~10%+ with wind	~5%
Sweat from skin evaporates = cooling (blocked by humidity)	Infrared heat from body surface to cooler environment	Moving air carries heat away from skin surface	Direct contact heat transfer to coolerground/surfaces

Blood: The Key Component — How Dehydration Happens

Normal Function

- Delivers oxygen & nutrients to muscles & organs
- Carries heat from working muscles to skin for dissipation
- Volume: ~5L (men) / 4L (women)
- Sweat comes from blood volume initially

When Hydrated

- ↓ Blood volume → less blood to skin → heat not dissipated
- ↑ Heart rate to compensate → excessive fatigue
- ↓ Blood to gut → slower fluid absorption
- ↓ Blood to muscles → reduced work capacity
- ↓ Blood to brain → poor concentration, accidents

⚠ Thirst only begins at 2% dehydration — workers are already impaired before they feel thirsty! Typically 40% of workers arrive to work already dehydrated.

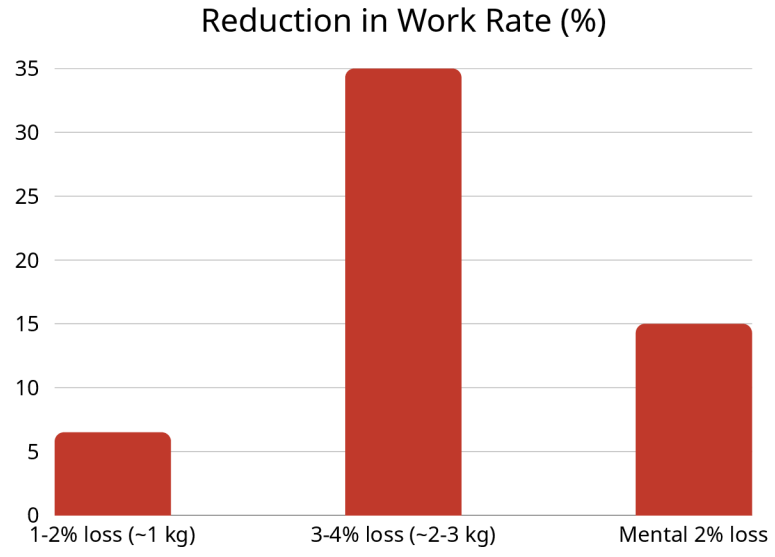
Dehydration: Impact on Work Performance

Performance Decrements (Bates et al., 2013):

1–2% dehydration:
6–7% reduction in physical work rate

3–4% dehydration:
22–50% reduction in work rate (moderate to hot environments)

Mental performance:
Begins declining at just 2% dehydration — accident risk rises significantly



What You're Losing: Sweat Composition & Rate

What Is Sweat?

Water	**Primary component**	Must be replaced continuously
Sodium (Salt)	**~40 mmol/L/hr**	Largest mineral loss — critical to replace
Potassium	**Small amount**	Lost from intracellular fluid
Magnesium & Calcium	**Virtually none**	Not a significant concern

A 10-Hour Shift in Gulf Heat

~600 mL/hr
Sweat rate at 35°C / 50% RH

6 Litres
Total fluid loss in a 10-hr shift

~13 g Salt
= 3 teaspoons — lost daily in sweat (must replace!)

Hydration: Practical Guidelines for Workers

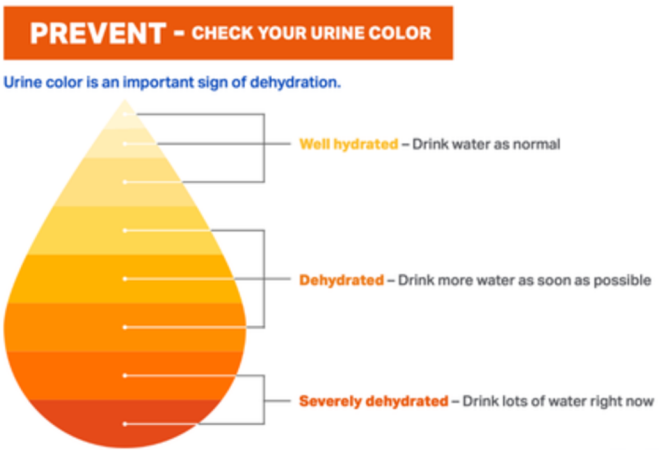
What to Drink

✓ Water + electrolyte solution
3–4g carbohydrate, 10–20 mmol/L sodium per 100ml is ideal

✓ Programme drinking
Small amounts frequently — do NOT wait until thirsty

✗ Avoid high-sugar sports drinks
Most contain >7% sugar — slows gut absorption

✗ Avoid caffeinated drinks on-site
Coffee, Coke, energy drinks are diuretics (increase urination)



✗ Never use alcohol to rehydrate
3L beer when 3L dehydrated → still 3.5L deficit!

Caffeine & Alcohol: Diuretics That Make It Worse

Caffeine Content in Common Drinks

Percolated coffee (250 mL)	100–200 mg
Instant coffee (250 mL)	70–180 mg
Tea — 5 min brew (250 mL)	30–80 mg
Energy drink – Red Bull (250 mL)	80 mg
Coca-Cola (375 mL can)	75 mg
Tea — 1 min brew (250 mL)	15–55 mg

Alcohol-induced Dehydration Effect

Scenario: Worker is dehydrated by 3 kg (3 litres)

Drinks 3L Water
Net GAIN 3 kg
Fully rehydrated

Drinks 3L Beer
Net LOSS 0.5 kg
Now 3.5 kg dehydrated!

On-site: Water and electrolytes ONLY. No coffee, cola, or energy drinks.

Both caffeine and alcohol are DIURETICS — they cause the body to produce MORE urine, worsening dehydration.

Heat-Related Illnesses: From Fatal to Mild

Heat Stroke FATAL RISK	**Signs:** **Body temp >40°C**, confusion, **no sweating**, hot dry skin, loss of consciousness, convulsions **Action:** EMERGENCY: Call ambulance. Cool immediately — remove clothing, wet skin, increase airflow.	**Prevention:** Monitor TWL & core temp; mandatory rest cycles
Heat Exhaustion SERIOUS	**Signs:** Headache, nausea, weakness, thirst, dizziness. **Clammy skin**, rapid pulse. **Temp normal or slightly elevated**. **Action:** Rest in cool place. Drink fluids. Severe cases: 1–2 days recovery. No permanent effects if treated.	**Prevention:** Adequate hydration; TWL work limits; shade access
Heat Cramps MODERATE	**Signs:** Painful muscle spasms from electrolyte imbalance caused by heavy sweating. **Action:** Replace water AND electrolytes. Drink every 15–20 min in hot environments.	**Prevention:** Program drinking with electrolytes every 15–20 min
Heat Rash / Fatigue MILD	**Signs:** Blocked sweat ducts → rash (hot humid conditions). Mental strain, reduced alertness. **Action:** Cool breaks, regular bathing. Acclimatisation reduces heat fatigue over time.	**Prevention:** Cool rest areas; acclimatisation programme; loose PPE

Heat Collapse & Heat-Related Safety Accidents

Heat Collapse (Fainting)

Who is at risk:
Workers unaccustomed to heat who stand upright and immobile for extended periods

Mechanism:
Blood pools in legs → inadequate venous return → insufficient blood to the brain → fainting

Signs:
Dizziness, pale/clammy skin, sudden collapse without prior warning of heat exhaustion

First Aid:
Lie flat with legs elevated; move to cool area; monitor closely; call medical if unresponsive

Prevention:
Keep workers moving (even light activity); acclimatisation programme; no standing still in heat

How Heat Causes Accidents

Sweaty palms:
Reduced grip → dropped tools, equipment slips, handling errors

Dizziness & lightheadedness:
Fall from height, loss of balance on scaffolding or plant equipment

Fogging of safety glasses:
Obscured vision → contact with moving machinery or hot surfaces

Hot surfaces / steam:
Contact burns — impaired judgement delays avoidance reaction

Reduced alertness:
Slower reaction time, poor decision-making, missed hazard warnings

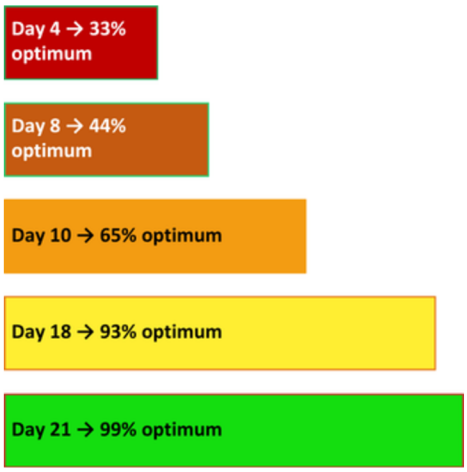
Irritability & anger:
Interpersonal conflict → distraction, reduced focus, physical incidents

Acclimatisation: The Body Adapts to Heat

What Acclimatisation Achieves

Blood volume	Increases up to 30% (average 21%)
Sweating	Starts 15% earlier; rate increases 50%
Sodium in sweat	Decreases 29% — less salt lost
Heart rate	Falls from 153 → 127 bpm at same workload
Core temperature	Falls from 38.8°C → 38.1°C at same workload
Productivity	Measurably improved; accident risk reduced

Acclimatisation Timeline (Physiological)



⚠ Loss: 50% lost after 1 week off; full loss after 4 weeks. Requires >2 hrs elevated metabolic rate/day to maintain.

Individual Risk Factors for Heat Illness

Age
Older workers have reduced cardiovascular reserve; less efficient sweating mechanism

Body Weight (BMI)
BMI >30: 2× injury risk. Less surface area relative to body mass — less cooling capacity. More heat generated

Physical Fitness
Fit workers have greater aerobic capacity — withstand more heat stress; acclimatise faster

Prior Illness
Flu, diarrhoea, vomiting, hangover = pre-dehydrated. Short-term illness dramatically raises heat illness risk

Medication
Some medications impair sweating or blood pressure control. Workers on medication need medical clearance for hot work

Acclimatisation Status
New starters need 10–21 days to acclimatise. Never let new workers work alone in first week

Alcohol Night Before
Alcohol is a diuretic — workers arrive dehydrated. Night-before drinking is a major heat illness risk factor

How to Prevent Dehydration – Personal Level

1

Drink water before work each day

Come to work well Hydrated

2

Drink at least 2 litres of water every 2-3 hours during works

Maintain adequate Hydration throughout the day

3

Check your urine color It should be pale yellow

Self assess hydration

4

Add a little extra salt to your meals

Maintain sodium electrolytes

5

Take regular breaks in hot weather

Self-pace work – do not push beyond the bodies limits.

6

Get plenty of sleep at night

Allow time at night to recover from the heat stress during the day

7

Eat fruits & vegetables everyday

Provide a well balanced health diet to help body recover. Avoid coffee, cola, high sugar and fatty foods

8

When unwell, inform your supervisor

Know the signs of heat illness and report (feeling faint, dizziness, fatigue, headache, nausea, vomiting, cramps)

Scarlet Tech specializes in delivering tailor-made, state-of-the-art HSE instruments for accurate measurement and real-time monitoring in demanding environments. Comprehensive range of professional HSE instruments: wireless anemometer, wireless crane camera system, heat stress meter, class 1 & 2 sound level meter.