

Hafeet Rail Cold Chain Standard Operating Procedures (SOP)

A technical operational guide detailing electrical reefer wagon integration, IoT telematics monitoring, and border fast-track protocols for perishable foods, agricultural commodities, and pharmaceuticals.

**Critical Cold Chain Mandate:** Zero-tolerance policy for temperature deviations exceeding  $\pm 0.5^{\circ}\text{C}$  from defined setpoints. All cargo moving through the UAE–Oman rail corridor must comply with the technical loading, electrical connection, and telemetry requirements set forth in this SOP.

1. ELECTRICAL SPECIFICATIONS & REEFER POWER INTERCONNECTION

Hafeet Rail provides dual-power architecture for temperature-controlled ISO containers (Reefers). Shippers must ensure equipment compliance with wagon-mounted Power-Pack Units (PPU) or individual clip-on genset standards.

| TECHNICAL PARAMETER        | STANDARD REQUIREMENT                               | OPERATIONAL VERIFICATION STANDARD                                              |
|----------------------------|----------------------------------------------------|--------------------------------------------------------------------------------|
| Power Supply Output        | 460V / 3-Phase / 60Hz (or 380V / 50Hz)             | Pre-trip inspection (PTI) certificate valid within 24h of terminal gate-in.    |
| Plugging & Socket Standard | ISO 1496-2 Heavy-Duty CEE 32A / 4-Pin Marine Plugs | Waterproof IP67-rated connectors mandatory to withstand desert dust/humidity.  |
| Primary Wagon Powering     | Centralized Wagon Power-Pack Unit (PPU)            | Guarantees continuous electrical feed to up to 18 Reefer containers per block. |
| Redundancy Power Back-up   | Dual-Diesel Generator Units on PPU                 | Automatic failover engaged within 15 seconds of main circuit interruption.     |

2. COMMODITY TEMPERATURE & AIRFLOW PROTOCOLS

| COMMODITY CLASSIFICATION             | TARGET SETPOINT (°C)          | AIR EXCHANGE / HUMIDITY CONTROL          | PRE-COOLING PROTOCOL                                |
|--------------------------------------|-------------------------------|------------------------------------------|-----------------------------------------------------|
| Deep Frozen (Meat, Seafood)          | -20°C to -25°C                | Fresh Air Ventilation: CLOSED            | Pre-cool container to -20°C prior to stuffing.      |
| Chilled Produce (Fruits, Vegetables) | +1.5°C to +4.0°C              | Ventilation: 15–25 m³/hr (CO2 expulsion) | Pre-cool cargo to setpoint to prevent pulping heat. |
| Pharmaceuticals & Biologics          | +2.0°C to +8.0°C (Controlled) | Humidity target: 50% - 60% Relative      | Mandatory GDP (Good Distribution Practice) audit.   |

3. MANDATORY IOT TELEMATICS & REAL-TIME MONITORING INTEGRATION

To maintain complete cold chain visibility along the line-haul, all reefer units mounted on Hafeet Rail rolling stock must feature integrated or clip-on IoT telematics connected to the operator's Control Center.

Required Telematics Sensor Matrix:

- **Supply / Return Air Temperature:** Calibrated dual-probe sensors logging data every 5 minutes.
- **Power Status & Voltage Monitoring:** Instant automated alert triggered upon power disconnect or phase drop.
- **Door Opening & Lock Status Sensors:** Optical sensors detecting unauthorized access during terminal dwell.
- **GPS & Geofencing Tracking:** Automatic location broadcasts along the Al Ain to Sohar rail corridor.

4. FAST-TRACK BORDER PROTOCOLS & CONTINGENCY MANAGEMENT

Border clearance delays represent the greatest risk to cold chain integrity. Hafeet Rail operates an expedited customs window for perishable goods.

| OPERATIONAL STAGE       | STANDARD OPERATING PROTOCOL                                                                   | TARGET EXECUTION TIME        |
|-------------------------|-----------------------------------------------------------------------------------------------|------------------------------|
| Digital Pre-Clearance   | Submit phytosanitary/pharma certificates via single-window platform prior to train departure. | T-12 Hours before loading    |
| Border Inspection (NII) | Drive-through Non-Intrusive Inspection (Scanner) without decoupling power feeds.              | < 15 Minutes per train block |
| Priority Yard Handling  | Reefer cars given first-priority discharge and immediate connection to depot power plugs.     | < 30 Minutes from arrival    |

5. EMERGENCY RESPONSE PLAN (BREAKDOWN PROTOCOLS)

Protocol for Power Interruption or Cooling Failure:

1. **Automated Escalation:** IoT trigger notifies the Rail Operation Control Center (ROCC) and shipper within 3 minutes of a fault signal.
2. **Mobile Technician Deployment:** On-duty technicians dispatched at Al Ain or Sohar intermodal yards with spare clip-on gensets.
3. **Thermal Hold Limit:** Modern insulated reefer containers retain safe temperatures for up to **6 hours** without active power, provided doors remain sealed.
4. **Cold-Box Swap:** If repair time exceeds 2 hours, cargo is moved to a standby powered reefer wagon at the nearest siding.