1) PRD — Product Requirements Document

1.1 Problem & Goal

Restaurants and bakeries need consistent, high-throughput injera without relying on expert operators. The machine must deposit batter in evenly spaced concentric rings and bake a Ø30 cm injera in ≤5 s with uniform “eyes” and repeatable thickness.

1.2 Users & Use Cases

- **Primary user:** Line cook/operator in a commercial kitchen.
- **Secondary user:** Production manager/owner.
- **Tertiary user:** Service technician.

Core use cases

1. Start of day warm-up and sanitation check.
2. Continuous production (single operator): load batter, initiate cycle, remove baked injera.
3. Quick recipe switch (temperature/flow tweaks).
4. Cleaning-in-place (CIP) at shift end.

1.3 Product Scope

- Single heated plate (θ-axis only, no radial motion).
- One pump feeding **7 outlets** on a rigid nozzle arm (concentric rings).
- Closed-loop plate temperature control using PT100 + MAX31865 + SSR.
- Safety: dual-channel E-stop (2NC), cover interlock, thermal cutoff.
- HMI: basic status/alarms and setpoints; optional serial console.

1.4 Key Performance Indicators (KPIs)

- **Cycle time:** ≤ **5.0 s** per Ø30 cm injera (steady-state).
- **Thickness: 2.0 mm ± 0.3 mm**.
- **Temperature regulation: ±3 °C** around setpoint during cycling.
- **Yield (visual uniformity/eyes):** ≥ **95%** pass rate after warm-up.
- **Uptime:** ≥ **95%** during an 8-h shift.
- **Sanitation (CIP):** complete in **≤30 min**.

1.5 Non-Goals (V1)

- Multi-plate indexing carousel (future).
- Vision-based quality feedback loop (future).
- Cloud telemetry/OTA (future).

1.6 Constraints & Assumptions

- **Geometry:** Ø30 cm, 2 mm thickness; batter ≈ **141 mL** per injera.
- **Flow:** total ≈ **28.3 mL/s** for 5 s; per-nozzle targets proportional to ring radius.

- **Power:** 230 VAC mains; 24 VDC controls (150–240 W).
- **Materials:** SS304/316 for food-contact; equal-length tubing.
- **Environment:** Indoor food production, ambient 15–35 °C.

1.7 Success Criteria (acceptance at pilot)

- Produce **10 consecutive injeras** within cycle time and thickness spec.
- Maintain setpoint temperature within **±3 °C** while cycling.
- Pass safety tests: E-stop dual-channel cut, cover interlock, thermal cutoff.
- CIP completed ≤30 min with clean swab results.

1.8 Competitive/Reference Products

- Hwayihgin HY-910-CL; TaiwanTrade automatic injera machines; springrollsolution injera maker (reference only).

1.9 High-Level UX

- **HMI home:** status, setpoint temp, cycle button, alarm banner.
- **Recipe screen:** temp, cycle time, pump trim wizard.
- **Maintenance:** sensor status, counters, CIP checklist.

End of PRD v1.0 Draft