AI Engineer Technical Test – IAQ Control Logic

1. Objective

Implement the IAQ control logic as described in the attached flowchart. The flowchart contains both the logic sequence and the thresholds. Your implementation should process 1 week of sensor + HVAC data, apply the rules, and generate alerts and control actions.

2. Key Requirements

- **Logic Implementation:**
  Follow the flowchart exactly (IAQ alerts, dilution cycles, VAV/AHU/PAD control, RH/Temp conflicts, escalation, PSI filter actions).
  - Trigger IAQ alerts when pollutants/conditions exceed thresholds.
  - Run dilution cycles (up to 3, with persistence checks).
  - Apply control strategies (VAV, AHU valve, PAD).
  - Handle RH/Temperature conflict scenarios.
  - Escalate alerts if conditions remain unresolved.
  - Apply PSI-based filter actions.
- **Configurable Thresholds:**
  - Do not hardcode thresholds.
  - Store them in an external config file (YAML/JSON/INI) and load dynamically.
- Inputs:
  - CSV/Parquet file with 1 month of time-series data (sensor readings, HVAC states, PSI).
- Outputs:
  - Per-timestamp log (alerts, actions, reason codes, cycle state).
- Code Quality:
  - Clean, modular Python code
  - Provide unit tests for triggers, persistence, PSI mapping.
  - Include a README with assumptions and instructions.

3. Deliverables

- Code (Python modules + config file).
- Outputs (log + summary CSVs).
- README (how to run, dependencies, explanation).

4. Evaluation Criteria

- Correctness of flowchart logic.
- Config-driven design (no hardcoded thresholds).
- Robustness (handling missing data, rule conflicts).
- Clarity of outputs.
- Code structure, tests, documentation.

5. Additional Notes & Assumptions

1. Within the flowchart, you will notice references to certain machine learning models, such as "IDP to derive occupancy and outdoor-based temperature and IAQ offset value" and "T_{idp} will be derived based on the higher absolute offset value." For the purpose of this test, you do not need to implement these models. Instead, you may assume a constant offset value so that you can focus on implementing the flowchart logic.

2. PSI data should be retrieved from the official Singapore government API: https://data.gov.sg/datasets/d_fe37906a0182569d891506e815e819b7/view

3. Mapping table of IAQ Sensors to VAVs.

IAQ Label	VAV	ZONE	AHU
IDP-IAQ-L19-044	VAV L19-Z1-SA-12	ZONE 1	AHU-L19-01
IDP-IAQ-L19-045	VAV L19-Z1-SA-13	ZONE 1	AHU-L19-01
IDP-IAQ-L19-046	VAV L19-Z1-SA-18	ZONE 1	AHU-L19-01
IDP-IAQ-L19-047	VAV L19-Z1-SA-19	ZONE 1	AHU-L19-01
IDP-IAQ-L19-048	VAV L19-Z1-SA-20	ZONE 1	AHU-L19-01
IDP-IAQ-L19-049	VAV L19-Z1-SA-21	ZONE 1	AHU-L19-01
IDP-IAQ-L19-050	VAV L19-Z1-SA-17	ZONE 1	AHU-L19-01
IDP-IAQ-L19-051	VAV L19-Z1-SA-16	ZONE 1	AHU-L19-01
IDP-IAQ-L19-052	VAV L19-Z1-SA-15	ZONE 1	AHU-L19-01
IDP-IAQ-L19-053	VAV L19-Z1-SA-14	ZONE 1	AHU-L19-01
IDP-IAQ-L19-054	VAV L19-Z1-SA-11	ZONE 1	AHU-L19-01
IDP-IAQ-L19-055	VAV L19-Z1-SA-10	ZONE 1	AHU-L19-01
IDP-IAQ-L19-056	VAV L19-Z1-SA-09	ZONE 1	AHU-L19-01
IDP-IAQ-L19-057	VAV L19-Z1-SA-08	ZONE 1	AHU-L19-01
IDP-IAQ-L19-058	VAV L19-Z1-SA-01A VAV L19-Z1-SA-01B VAV L19-Z1-SA-03 VAV L19-Z1-SA-04	ZONE 1	AHU-L19-01
IDP-IAQ-L19-059		ZONE 1	AHU-L19-01
IDP-IAQ-L19-120		ZONE 1	AHU-L19-01
IDP-IAQ-L19-060	VAV L19-Z1-SA-06	ZONE 1	AHU-L19-01
IDP-IAQ-L19-061	VAV L19-Z1-SA-07	ZONE 1	AHU-L19-01
IDP-IAQ-L19-062	VAV L19-Z1-SA-05	ZONE 1	AHU-L19-01
IDP-IAQ-L19-063	VAV L19-Z1-SA-23	ZONE 1	AHU-L19-01
IDP-IAQ-L19-064	VAV L19-Z1-SA-22	ZONE 1	AHU-L19-01
IDP-IAQ-L19-106	VAV L19-Z1-SA-25	ZONE 1	AHU-L19-01
IDP-IAQ-L19-070	VAV L19-Z1-SA-27	ZONE 1	AHU-L19-01
IDP-IAQ-L19-085	VAV L19-Z1-SA-29	ZONE 1	AHU-L19-01
IDP-IAQ-L19-086	VAV L19-Z1-SA-28	ZONE 1	AHU-L19-01
IDP-IAQ-L19-065	VAV L19-Z1-SA-31	ZONE 1	AHU-L19-01
IDP-IAQ-L19-114	VAV L19-Z1-SA-26	ZONE 1	AHU-L19-01
IDP-IAQ-L19-094	VAV L19-Z1-SA-36	ZONE 1	AHU-L19-01
IDP-IAQ-L19-095	VAV L19-Z1-SA-34	ZONE 1	AHU-L19-01
IDP-IAQ-L19-096	VAV L19-Z1-SA-35	ZONE 1	AHU-L19-01
IDP-IAQ-L19-097	VAV L19-Z1-SA-32	ZONE 1	AHU-L19-01
IDP-IAQ-L19-099	VAV L19-Z1-SA-37	ZONE 1	AHU-L19-01
IDP-IAQ-L19-119	VAV L19-Z1-SA-24	ZONE 1	AHU-L19-01
IDP-IAQ-L19-066	VAV L19-Z1-SA-30	ZONE 1	AHU-L19-01