8.4.Appendix Q: AI-Based Quality Assurance Concept – Documentation & Safety

8.4.5.1 Objective Ensure that all technical, organizational, and safety-relevant content of the *Sphere Space Station Earth ONE & Beyond* project is factually correct, consistent, and complete — and that life safety aspects (Safety) are verifiably met at all times.

8.4.5.2 QA Structure

QA Level	Focus	AI Function	Methods
QA-1: Factual Accuracy	Fact-checking (technology, figures, dimensions, processes)	LLM with technical fact and standards check	- Cross-check against internal "Single Source of Truth" (Sec. 8.4.2) - Check against external standards (ISO, NASA, ESA)
QA-2: Consistency	Uniformity between chapters and documents	Semantic comparison by AI	- Detection of contradictions (e.g., material density, break-even timelines) - Version comparison
QA-3: Completeness	Check that all mandatory content is included	AI-assisted checklist review	- Compare with master template for each document type - Flagging of MISSING items
QA-4: Safety Compliance	Life safety and evacuation standards	AI with safety rulebook & standards database	- Compare with Preamble criteria (Sec. 0.1) - Simulate emergency scenarios - Red-flag detection
QA-5: Traceability	Traceability & source referencing	AI-supported source-linking system	- Auto-linking of internal chapter numbers - Verification that all external sources are fully cited
QA-6: Presentation Clarity	Readability & audience fit	Language model with audience profile	- Adapt to pitch perspective - Consistent formatting & terminology

---

8.4.5.3 AI-Assisted QA Pipeline

1. **Import**: New or changed documents are automatically loaded into the AI QA workflow.
2. **Pre-Check (Syntax & Structure)**: AI checks format, chapter numbering, and table integrity.
3. **Semantic Analysis**:
   - Cross-document check (e.g., material data in 2.2 vs. 7.2.1)
   - Alignment of numerical values and terminology
4. **Safety Simulation**: AI simulates scenarios (e.g., fire, radiation leak, pressure loss) based on Sec. 2.1.5 & 2.1.6, compares procedures with standards, and flags deviations.
5. **Issue Tagging**:
   - `CONTRADICTION` – conflicting information
   - `MISSING` – missing mandatory content

- PLACEH0LDER – placeholder text without content

6. **QA Report**: Automatically generated table with:
   - Location (chapter, line)
   - QA category (see above)
   - AI recommendation for correction
7. **Review & Approval**: QA team reviews AI suggestions, confirms changes, and triggers versioning (Sec. 7.3).

8.4.5.4 QA Table Format (Example)

Chapter	QA Note	Description	AI Recommendation
2.2.4 vs. 7.2.1	CONTRADICTION	SiC/SiC material density stated differently	Use consistent values from material specification
4.3.7 vs. 6.1.6	MISSING	Break-even calculation missing in expansion chapter	Insert figures from 4.3.7
3.3.5	PLACEHOLDER	Communication channels not specified	Add social media and educational platforms

---

8.4.5.5 Safety-Specific QA Checkpoints

- **Technical Protection Systems**: Completeness of specifications (fire, radiation, meteoroids, biohazards)
- **Evacuation Logistics**: Pod capacity, access routes, drill frequency (Sec. 2.1.6)
- **Redundancy Checks**: Energy, life support, cooling
- **Auditability**: Safety protocols documented, verifiable, and versioned
- **Compliance**: Match with Preamble criteria & international safety standards

---

8.4.5.6 Operational Implementation

- **Automation**: AI QA runs after every document change or before each release
- **Versioning**: Each QA-approved version stored with review date and result
- **Dashboards**: Live overview of open QA findings, safety status, and document maturity level
- **Lessons Learned**: AI analyzes recurring error types and proposes structural improvements

---