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The 80-Year Horizon:

Bridging the EQ Knowledge Gap for

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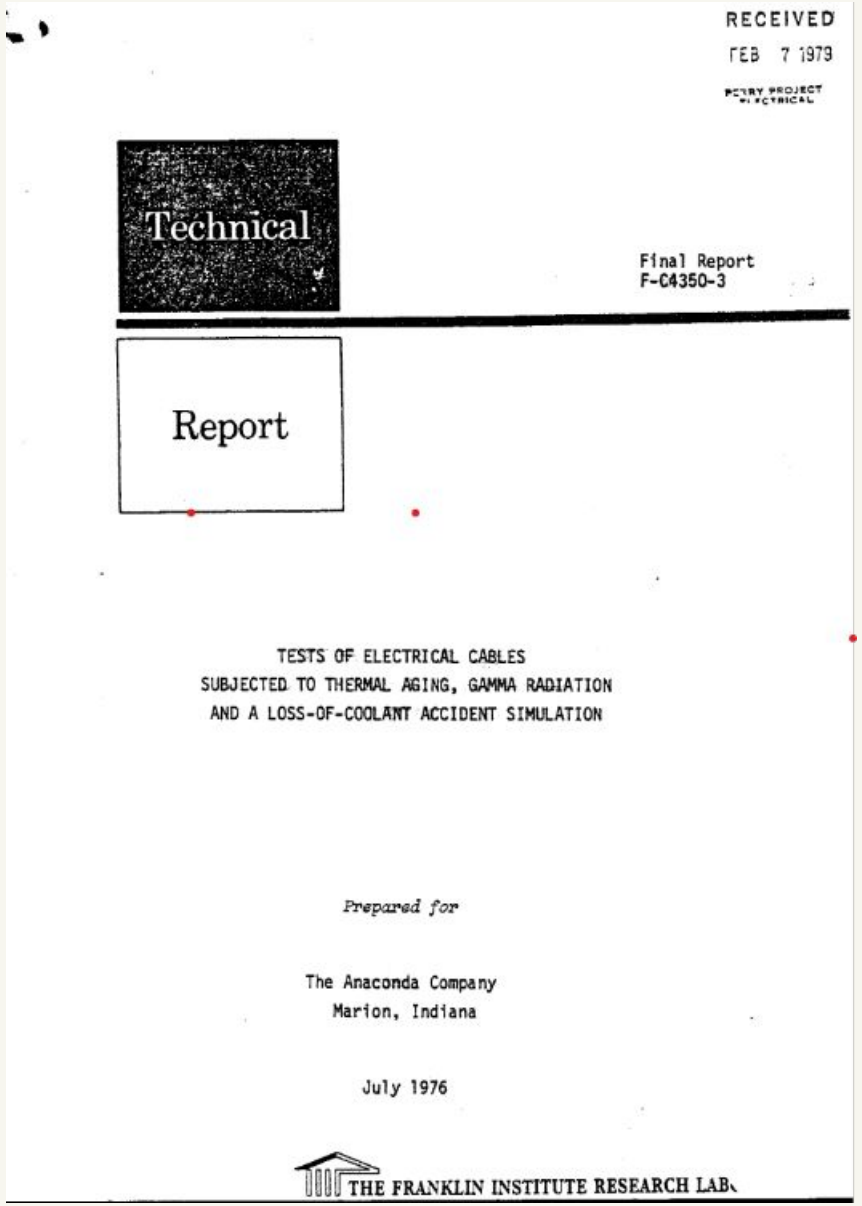
- Introduction: The New Frontier
- The Technical Challenges of 60+ Year Operation
- The EQDP as a Strategic Knowledge Asset
- Case Study / Strategy: Bridging the Gap
- Conclusion & Key Takeaways

The 80-Year Horizon:



RECEIVED
FEB 7 1979
PERRY PROJECT
ELECTRICAL

Technical

Final Report
F-C4350-3

Report

TESTS OF ELECTRICAL CABLES
SUBJECTED TO THERMAL AGING, GAMMA RADIATION
AND A LOSS-OF-COOLANT ACCIDENT SIMULATION

Prepared for

The Anaconda Company
Marion, Indiana

July 1976

THE FRANKLIN INSTITUTE RESEARCH LAB.

The New Frontier

The Transformation: From Fixed Life to "Living" Asset

The transition to **Long Term Operation (LTO)** represents a move away from the "design-and-forget" mentality of the 20th century.

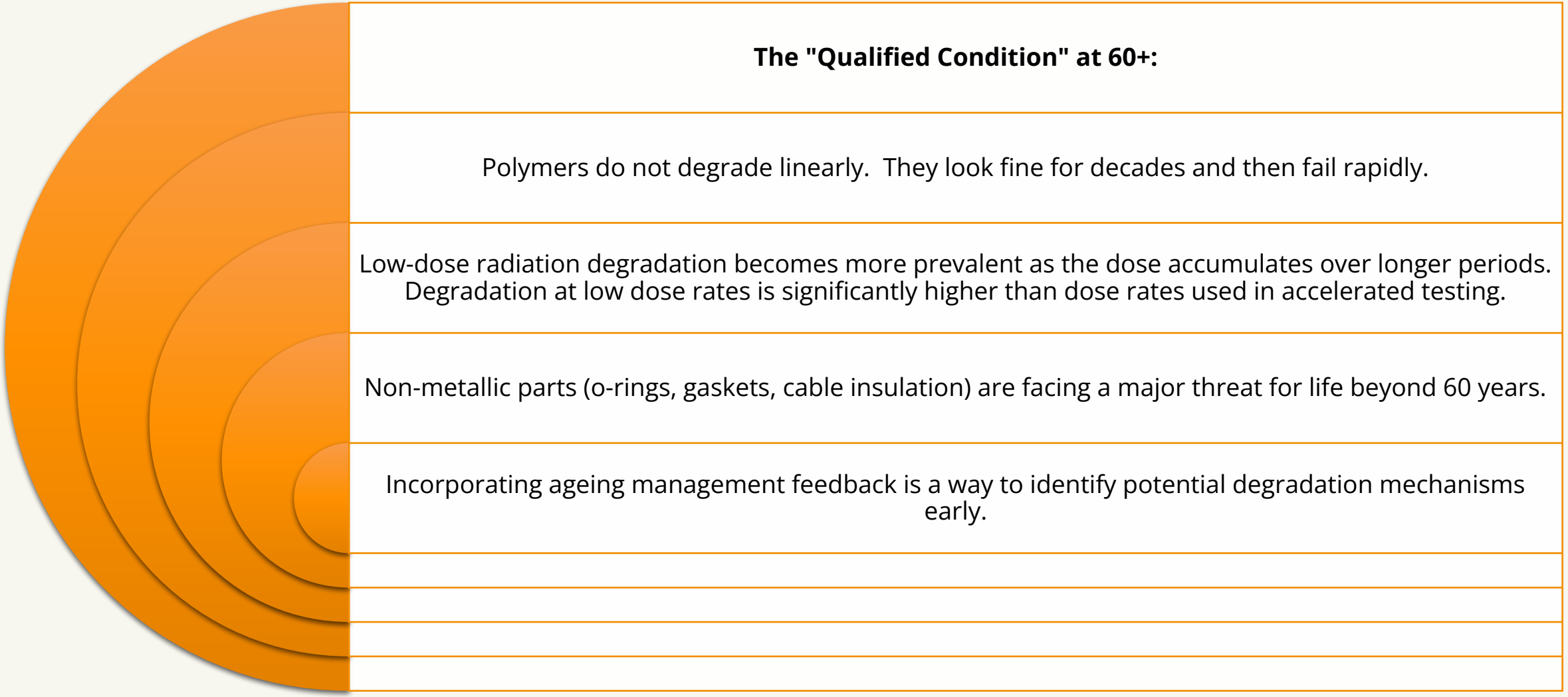
The Original "40-Year" Philosophy: Most legacy plants were licensed with a 40-year design life based on conservative, often arbitrary, engineering margins. Equipment was qualified using **Accelerated Ageing**—subjecting components to high heat and radiation for short bursts to simulate four decades of wear.

The 60-Year Extension (LTO): This was largely handled by "re-evaluating" those original margins. We found that the 40-year estimates were very conservative, so "pencil-sharpening" (refined calculations) often sufficed to get to 60.

The 80-Year LTO Paradigm: At 80 years, many of the "margins" are gone. We are now entering a period where **real-time degradation** may begin to match or exceed the original test data.

> **The "Living" EQDP:** The data package is no longer a static document in a vault; it must become a **Comprehensive Knowledge Base** that incorporates updating ageing research, ageing management program feedback, vendor similarity letters, and refined environmental mapping.

The New Frontier



The New Frontier

The Strategy: Recovering lost qualified life by replacing overly conservative "Design Basis" temperatures with actual, logged service data.

The Documentation: The EQDP acts as the primary record for these refined Arrhenius recalculations to justify the 80-year horizon.

Key Benefit: Provides a purely mathematical and document-based path to life extension without requiring new physical testing.

Environmental Margin Recovery

The "Qualified Condition" at 60+:

Synergistic Effects

The combined effect of heat + radiation + humidity is often worse than the sum of their parts. By year 65, these synergistic effects can lead to "unanticipated ageing" that wasn't included in the original Qualification Report.

Traditional EQ (0-60 Years)	LTO EQ (60-80 Years)
Sequential Testing: Heat then Radiation.	**Simultaneous Stressor Analysis:** Justify through documentation why original sequential testing remains conservative.
Conservative Constants: Use of generic E_a (Activation Energy).	**Activation Energy Sesnitivity Studies:** Use literature to prove the chosen E_a remains valid into the 80-year “cliff-edge”.
Theoretical Life: Based on the Arrhenius equation.	**Knowledge-Based Life:** Refined Environmental Mapping.

The Risk of Information Decay:

Retiring Experts

Obsolete Vendors

Degrading Paper Records

The Risk of Information Decay: Retiring Experts

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Loss of Tribal Knowledge

The Interpretation Gap

New engineers may struggle with 1970s terminology, handwritten data logs, etc. New regulators may interpret standards differently.

The Solution is the EQDP

Telling the story.

Documenting critical thinking for why modifications were made, solutions implemented, justification for input.

Don’t use it as a simple data dump

The Risk of Information Decay

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Obsolete Vendors

Non-existent OEMs

- Many Original Equipment Manufacturers (OEMs) have merged, been bought out, or declared bankruptcy. The original "Type Test Reports" or "Certificates of Conformance" are often no longer available from the source.

Material "Drift"

- Even if a vendor still exists, the chemical formulation of their polymers (O-rings, cable jackets) may have changed. A part with the same model number in 2026 may not have the same "Qualified Life" as the one installed in 1982.

The Solution is the EQDP

- It must contain any Similarity Analyses
- Include letters from vendors stating the formula of the parts are the same
- Include letters from vendors denoting part number changes but no physical changes to the part
- The EQDP must contain references to CGD records.

The Risk of Information Decay: Degrading Paper Records

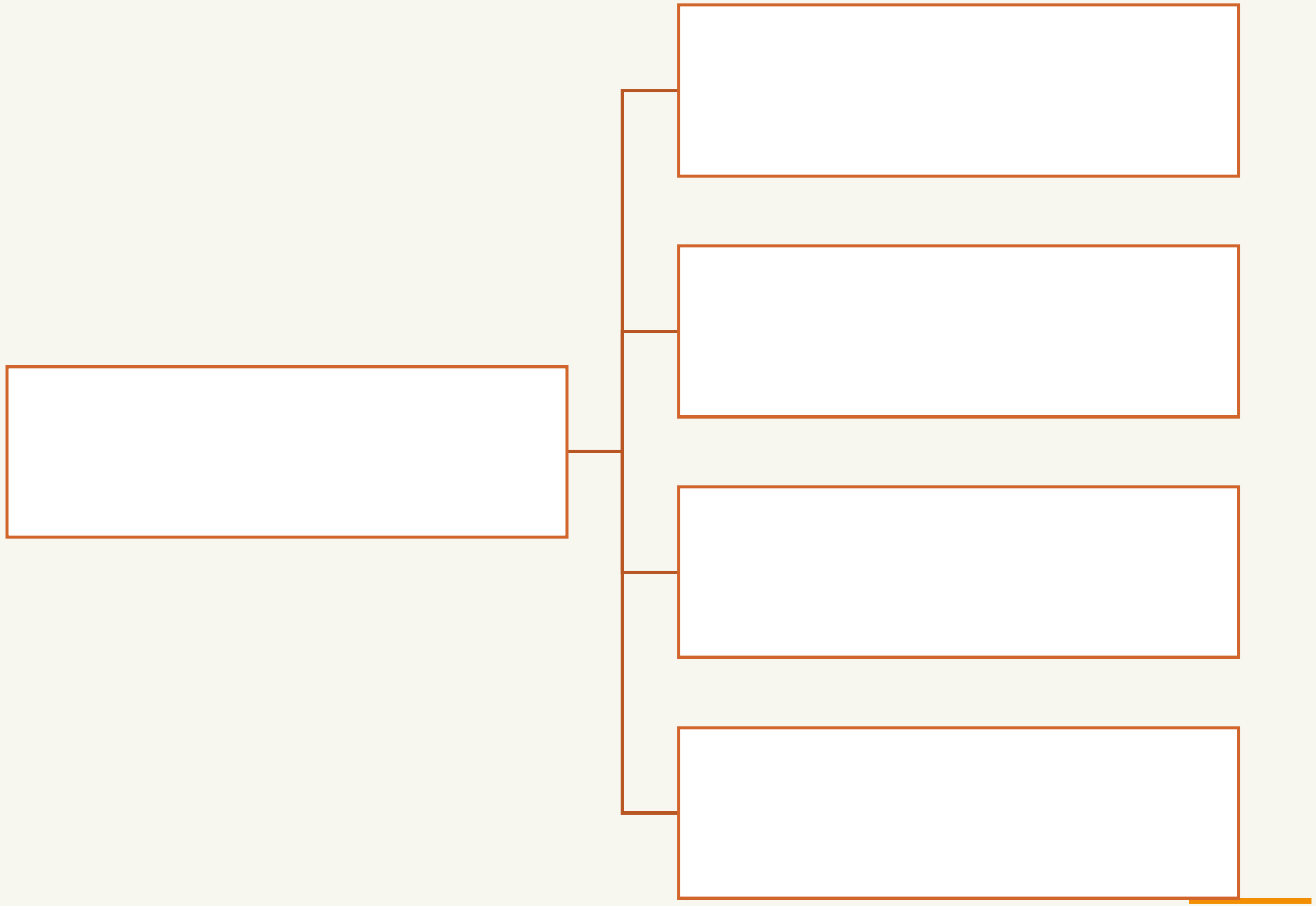
The Legacy Risk	Long Term Operation
Expert-Centric: Ask Peter – he knows this valve.	**Process-Centric:** The EQDP *is* the expert.
Paper-Based: Stored in a climate-controlled vault.	**Digital-First:** Searchable, verified, and backed up.
Static: Filed once and rarely touched.	**Dynamic:** Updated with Ageing Management data.

The EQDP as a Strategic Knowledge Asset

Why the EQDP Matters More at 80 Years

- Beyond Compliance: The EQDP becomes a strategic record
- Captures the engineering logic behind qualification.
- Integrates ageing management and monitoring data.
- Digital, searchable, traceable.
- Moves from document to knowledge system.

What a Modern EQDP Should Contain



Case Study: Recovering Qualified Life Through Data

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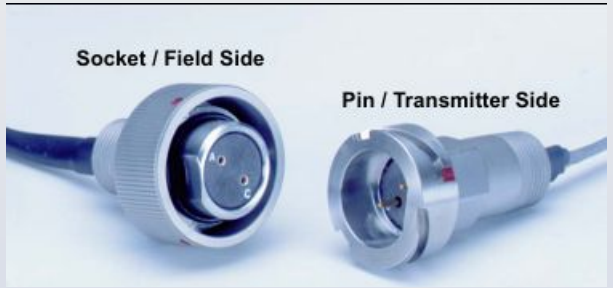
Component: EGS Electrical Connectors

Original Qualified Life: 21 years based on 60°C.	Measured Temperatures: maximum of 55°C.	Outcome: Arrhenius recalculation +21 years.	Updated Qualified Life: 42 years.



Ageing Time: 100 hrs
Ageing Temp: 126°C
Ea = 1.31eV
Limiting subcomponent:
Nordel O-ring

Documentation avoided physical re-testing.

Case Study: The Engineering Ultimatum

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Strategy A: Regulatory Margin Recovery

The Action: Dive deep into historical qualification data packages.

The Leverage: Use refined calculations to prove the existing component is safe for 80 years.

The Goal: Solve the 80-year LTO challenge purely at a desk.

Strategy B: Physical Overhaul

The Action: Accept the data gap and schedule a physical maintenance intervention.

The Footprint: Coordinate system isolation, technician radiation exposure, and labor hours.

The Goal: Mechanically replace the component during a scheduled outage.

Which path would you take?

Case Study: Evaluating a Valve O-Ring for 80-Year Operation

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Component: Safety-related elastomeric O-ring

Challenge: Vendor still manufactures part, but nuclear pedigree discontinued.

Technical Risk: Potential formulation drift; missing historical vendor data

Solutions: Capture similarity evidence, Commerical Grade Dedication, engineering rationale (Fourier Transform Infrared (FTIR) spectroscopy, Dimensional analysis)

Outcome: Qualification preserved and documented in EQDP

Key Takeaways

• 80-year LTO is fundamentally a documentation challenge.

• The EQDP must become a living, narrative-driven knowledge system.

• Margin recovery enables life extension without new testing.

• Documented justification mitigates information decay risk.

Final Thought

The plants were built for 40 years. The technology can take us to 80 years.

Only knowledge can get us all the way there.

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