PMT Screening & Partial Life Test Failures

Amato 7/04

Cause outline – how did we pass the original qualification of the new design but fail the follow on tests. Summary of possibilities ;

- **A. The Stresses Increased –**
  - **–RTV material properties changed**
    - **•Test new batches for CTE, modulus, Poisson's ration**
    - **•Develop new test to more accurately confirm early poisons ratio tests and data sources**
    - **•Retest old batch if possible for CTE, Poisson's ratio, modulus**
    - **•Compare test results with old test results, data sources and assumptions**
    - **•Use strain gauge tests to test for strain differences between old and new PMT batches and to correlate stress model**
  - **–PMTs that failed were unusual – diameter and glass thickness vary between tubes**
    - **•Look at new centering step data for diameters**
  - **–Less likely causes we must still disprove – large bubbles in RTV causing stress concentrations, Thermal vac chambers in error and we actually went much colder, etc**

- **B. The photo-multiplier tubes became weaker over time –**
  - **–Exposure to moisture over time has propagated glass flaws or made flaws much easier to propagate at lower stresses**
  - **–Handling - very unlikely with new handling procedure**
  - **–Is there any test of bare PMTs that could help see a weakening?**

- **C. The stress analysis and /or assumptions were flawed AND we were lucky on what were demanding qualification tests**
  - **–RTV properties and property tests were wrong to begin with – compare results of first bullet of A above**
  - **–Hard to understand how 5 tubes could go to multiple cycles at -60C and 4 tubes could go to -40C without failure. Used as controls but none have failed yet. Retest with very low temperature test. Test 7 PMTs potted with old RTV batches but never cycled.**
  - **–Review stress model again. Devise and use strain gauge tests mentioned in bullet 1 of A above to correlate model. Add non-linear ability to model.**

Current PMT Solution Paths Amato 7/04

- **Modified Potting Solution** – ***understand the new variables and stresses in the potting materials (S.S, C.H.)***
  - **RTV or more likely an alternate**
  - **Must understand exactly how the latest PMTs failed**
  - **Slit-potted design. May even be able to do this to already potted PMTs**
  - **Removal methods for already potted PMTs**

- **Thermal control solution** – ***don't let the PMTs see the stress of lower temperatures. (G.U., T.M.)***
  - **Heaters to -5 or 0C, Must determine via test what is warm enough**
  - **Allows us to fly PMTs that have already been potted**

- **Mechanical solution** – ***get out of the potting business since it looks like the material properties vary too much for these flawed tubes. (S.S, M.A.)***
  - **Partial CTE compensation design. Uses modified existing housings with inserts, does still add some stress but mostly compressive**
  - **Quasi kinematic mounts. Various forms. Simple versions may be able to use existing housings with inserts**
  - **Bonding release designs. Releases bonding on one side, grooved housings keep PMT from slipping**

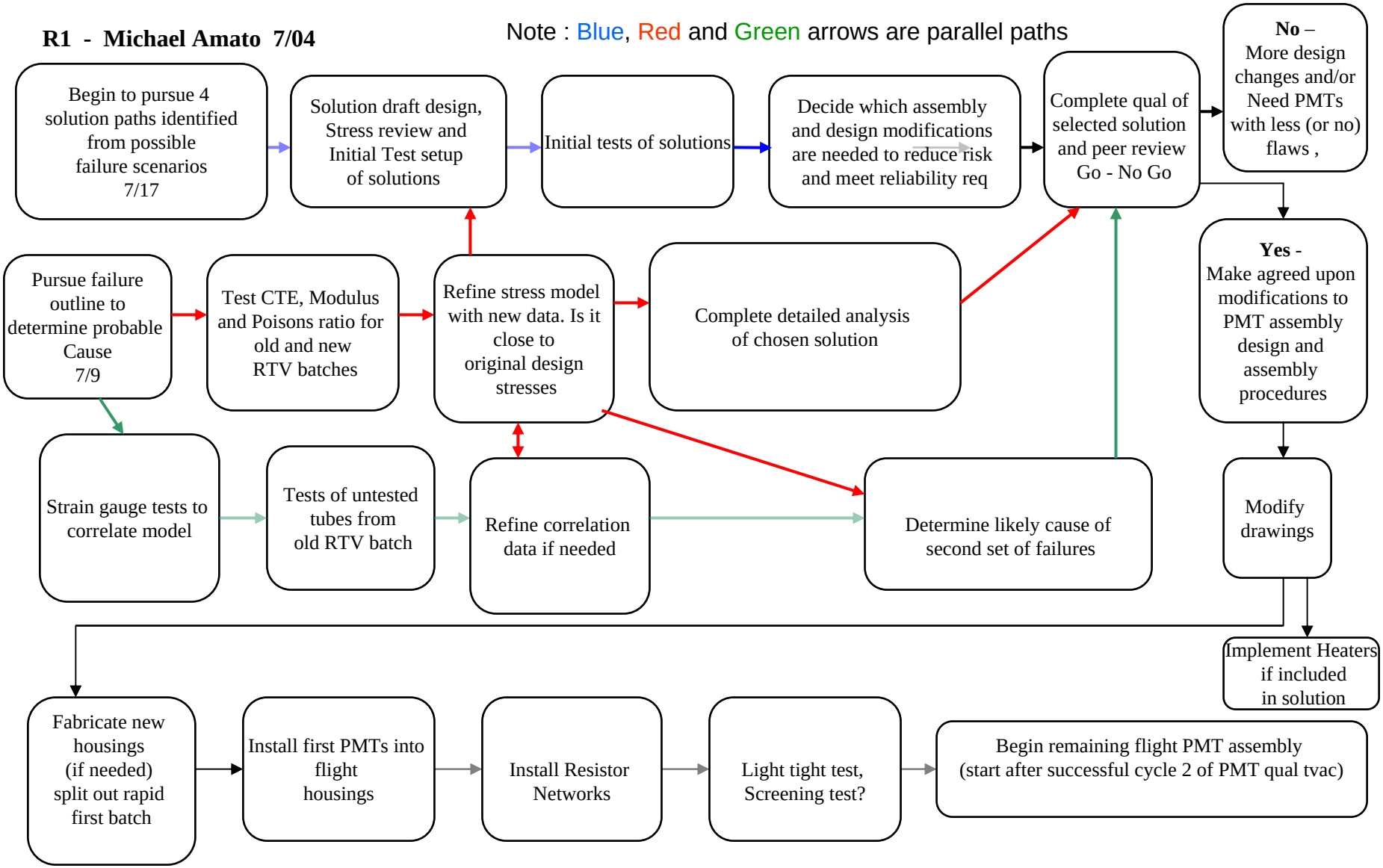
- **Determining Yield in current design** – ***see if there is a screening test that stresses the PMTs in a way that identifies almost all the PMTs that will fail without consuming lifetime of the PMTs that pass or making them more likely to fail. (C.H., W. T.)***
  - **Probably have to screen and partial life test large number of PMTs (which may be tough to then use as flight) to show it could work.**

- **Any combination of above with new PMTs** ***without so many glass flaws (R.H., C.H.)***
  - **First 6 units with modified Hamamatsu process are not flawless but are all dramatically better than any of the original tubes we have**

PMT Weakness Issue Basic Top Level Paths - The sequel

R1 - Michael Amato 7/04

Note : Blue, Red and Green arrows are parallel paths



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PMT Weakness Issue Testing and Modification Flow - draft

R1 - Michael Amato 7/04

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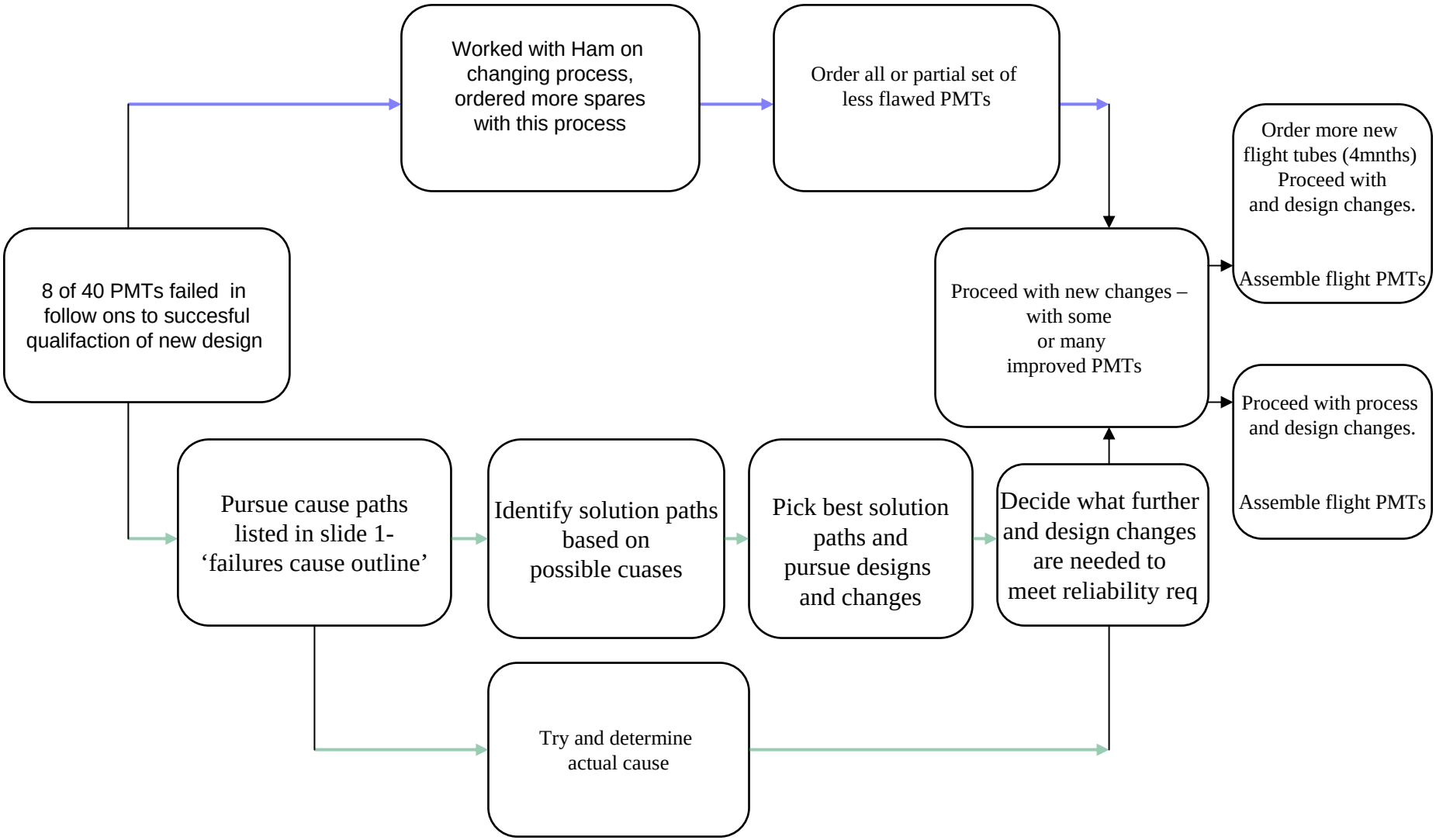

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