

## The Monopoly Creating Rocket Engine that Never Flew:

This engine was part of two rocket programs, and never flew. While test engines were burned on the stand, including an all-up prototype first stage. The rocket engine itself never flew, or entered production.

If you haven't guessed we are talking about the North American Aviation Rocketdyne Division, E-1 rocket motor.

Developed as an alternative to the potentially problematic Aerojet General LR87-AJ-3 Kerolox engine The E-1 was a Scaled-up member of the very large LR-79 family. And as such is directly related to the engines that powered Atlas, Thor, Jupiter, Delta I,II,III and Saturn I.

Originally funded as a belt and braces "evolved" alternative to the LR87-AJ-3 for Titan I, the E-1 engine would be delayed, and then due to engineering issues cause its own cancellation from the Titan program. The issue being a lack of a stable burn cycle in the combustion chamber leading to exploding combustion chambers. Those same engineering issues, once solved, allowed Rocketdyne to actually make the F-1 engine and provided the engineering know-how about how to make big bell rockets have an efficient and sustained burn cycle.

While it was still in the Titan Program, the Army Ballistic Missile Agency took an interest in the E-1 for their Juno V rocket. The Juno V was to be the next big satellite launcher. But the Army itself was not really interested in spending money on such a large rocket. As we all probably know, the Juno V was later renamed "Clusters Last Stand" err excuse me "Saturn S-I!" To keep costs down a single thrust plate would carry 4 E-1 rockets under a cluster of tanks made on the Redstone and Jupiter tooling (no they were not tanks ACTUALLY made of Redstone or Jupiter rockets, just tanks made re-using some of the same tools.) The First stage would be very cost effective in the mid-1950s when it was planned. But all the complicated connections and the continual spiral in cost of labor vs cost of materials would make it very expensive to make in the 1970s. With 4 E-1 engines the Saturn I S-I stage would be very efficient with a good throw weight (a military term for warhead mass flown to x nautical miles away from the launch site) and would be capable of carrying potentially 25,000lb payload to low Earth Orbit. But again, all that changed the day the USAF canceled the E-1 development contract. As stated above, the US Army (the people who "owned" ABMA) didn't want to put any more money into the still named Juno V as there was no warhead in need of such a massive rocket and no mission requirement for the US Army to launch a giant satellite. With no funding the E-1 was likely doomed to failure. Worse, ABMA was working with the not officially official ARPA (latter DARPA, latter ARPA and now again DARPA.) At the time ARPA had a small budget to play with for getting Juno V to a usable state... Then the Eisenhower Administration did the unthinkable. They took Space away from the military and gave it to a re purposed agency, NACA... which became NASA. ABMA would be split in two, and partially transferred to NASA as would many other entities. This would cause a lot of political problems between the military, ARPA (soon to be renamed DARPA) and the new NASA administration.

In the confusion and chaos at this time, ARPA who still had 10 million dollars to spend offered to fund the continued engineering effort on the E-1 rocket engine for ABMA. Von Braun,

Koelle, and company decided that it was better to have a fully engineered design than one that was mostly engineered to hand to the new NASA administration at the start of the new year. So instead of funding the E-1 engine for another year (and it had probably 2 or 3 years of additional engineering and testing to go before it would be flight ready.) Instead, they contacted Rocketdyne (now spun off from NAA) and asked about a slightly up-thrusted S-3D variant for the new Saturn I stage, as a temporary measure until a F-1 powered first stage could be developed! Rocketdyne looked the gift horse right in the mouth and took the 10million to make the X-1 and quickly thereafter the H-1 engines. Yes, you read that right, Koelle and Von Braun were looking at replacing the cluster tank S-I stage with a single tank, single F-1 engine even before NASA took over the Saturn program.

Thus ends the story of the E-1s development. If the E-1 had been completed, it is doubtful that it would have done anything except make the Saturn I rocket more expensive. The gain in First stage thrust, while more than capable of launching an all up Apollo CSM stack, would have little use that we can see with hindsight. However, if the E-1's engineering and design had not been undertaken, the Saturn V rocket would have taken much longer to develop due to the much longer development cycle that would have resulted for the F-1 engine and likely the LR87-LH2. So without the E-1 we might not have made it to the moon before 1970. Without the E-1 more perilous engineering choices might have been made. Without the E-1 the Saturn Moon flights might have HAD to be Earth Orbit Rendezvous instead of the Lunar Orbit Rendezvous that was flown. Instead of the Saturn V we might be seeing Saturn C-2 and Saturn C-3 rockets flying.

The results of the E-1 cancellation can clearly be seen throughout the Apollo program as well as with various other programs:

- The Engineering staff that was devoted to the development of the E-1 was transferred to developing the J-2 engine
- The know-how of why the E-1 did not work well in early tests directly solved the same problem with the mighty F-1, helping to reduce the F-1's development time.
- NASA threw Rocketdyne a bone by giving them the J-2 contract. Their proposal was 2nd best overall but Rocketdyne had the engineering staff ready to take the ball over the finish line... and they were not in an un-related CRASH program like the number one proposal...

It is interesting to consider what would have happened if the E-1 "won" the Titan Engine contract.

- Rocketdyne would have to make a Hypergolic fueled E-1 for the latter Titan II. This alone would lead to a lot of "fun" times for Rocketdyne as they had very limited experience with hypergolic and caustic fuels.
- The above might have resulted in the cancellation of the F-1 engine by Rocketdyne
- By the time of the Saturn Flights the E-1 would have grown in thrust even with Kerolox fuel.

- E-1 would likely have been in production right through the 1980s at-least meaning newer versions would be developed. After all the USAF/NRO preferred the Titan rocket for it's larger payloads. Even though Atlas could lift nearly as much the Titan rocket was preferred.
- An updated S-I stage would likely have been developed assuming additional Saturn Purchases.... with 4 E-1s instead of the larger and more expensive F-1. Because Engine development and engineering costs are spread across both Titan and Saturn. Even if Saturn was Kerolox and Titan Hypergolic, the costs would still be less than continued engineering costs for the much larger F-1.
- Aerojet General would likely see the LR87-LH2 power the upper stages of Saturn, as they would not have been in a CRASH program to convert the LR87 to hypergolic fuel.
- Aerojet General engines would likely power the Space Shuttle with all it's engines. main LH2 as well as the OMS with the AJ10

Now here is the big caveat I must give with this particular document. There is very little source material available on the E-1 itself. Most everything comes from books on the Titan, F-1, Apollo Saturn program, notes from ABMA, ARPA and NASA and in each and every case the E-1 is mostly just a footnote itself in these documents. There is a lot we don't know about the E-1. I have tried to string what little info that was available in this document as well as the connections to other major rocket engines (the LR87, the J-2, the X-1/H-1 and the F-1) on how things fit together. And I pray that my trained conjecture is close to the mark.

The facts that we know about the E-1 are pretty simple

- ordered as one of two competing engine designs for the Martin Titan I ICBM
- made by Rocketdyne who had problems early on with combustion chamber explosions
- scaled up LR79 with changes to the bell shape to make more efficient at lower altitude
- Even though it was tested on a Titan I first stage, it was deleted from the Titan I program prior to actual Titan I prototype launches
- De-funded in 1959 by ABMA/ARPA in lieu of the X-1/H-1 program to make Juno V easier to present to NASA and we know this was a decision by Koelle with the full support of Von Braun
- There is not a good photo of an all up E-1. There is a distant shot of one being tested under a Titan I first stage, and there are several photographs of a Battleship bell/combustion chamber (with none of the turbopumps other associated hardware.)

All in all, the E-1 engine represents one of the more interesting "WHAT IF" changes that are included in BDB. If you haven't flown a Saturn I or IB with the E-1 you don't know what you are missing (you only need 4 of them in the outer ring on the S-I engine plate)

I am happy and thankful that this engine is in BDB.

