Why did New Glenn's booster only land on its second flight?

Yu. I. Lobanovsky

Summary

This paper examines so-called intermediate braking of New Glenn's booster before landing during its first and second flights. It is demonstrated that on this mode in the first flight, this booster exploded due to generation of Pogo-type oscillations during its engines operating at nominal mode with 100 % thrust. In the second flight, throttling the central engine to 80 % of nominal thrust and the two outer engines to 50 % suppressed this catastrophic process, allowing the booster to successfully land on the ocean platform.

It has been demonstrated that this way to combat Pogo used by Blue Origin is identical to a method never used before March 2024, but which SpaceX has already demonstrated seven times since then in Starship test flights, beginning with the third. It is also reported that this method is based on the results of an integrated theory of hydroacoustic oscillations in rocket engine fuel supply lines, described in a paper by the author of this work, which became publicly available in late 2023.

Keywords: *New Glenn, first flight, landing, Pogo, crash, hydroacoustic oscillations*

I. Introduction

As is well known, Blue Origin's new heavy, partially reusable, two-stage New Glenn launch vehicle completed two flights in 2025: the first on January 16 and the second on November 13. This rocket successfully delivered its payloads in both launches. The main difference between these flights was that its first, potentially reusable stage (booster) exploded in the first flight at the intermediate braking – a necessary step for landing on a platform located in the Atlantic. On the second flight, this stage successfully landed there [1].

The development of New Glenn rocket began no later than 2013 [1], and the process, judging by its external manifestations, was structured as a systems engineering approach, similar to what has been commonly done in the American rocket industry since Apollo program, in contrast to the development process of the more innovative Starship rocket system, which was created within the framework of an agile methodology. With a systems engineering approach, the final form of the designed system is determined relatively early in the development process and, if successful, at the end of development, involves conducting a relatively small number of tests of the entire system as a whole to confirm its operability and achieved characteristics. Currently, moderately innovative rocket system projects such as New Glenn are typically expected to be able to successfully fly from the first launches.

And in January 2025, boost of this rocket and the placement of payload into orbit, the traditional phases of flights of any launch system, went completely smoothly. But the most innovative element of New Glenn flight, the landing on the ocean platform, failed on the first flight: in the reentry burn, the first stage unexpectedly exploded [2]. Immediately after this flight, management of Blue Origin company stated that the second launch would follow in the spring no later than May [3], then in September, and then in October [4], but in the end it took place only in November, 10 months after the first, and was completed successfully without any significant visible problems [5]. This time, the intermediate braking went smoothly, and the landing process itself on the platform didn't cause any difficulties, since it, in fact, had already been practiced many times over the previous decade during many flights of the company's New Shepard rocket, which made manned jumps beyond the Karman line [6].

The purpose of this study is to identify what Blue Origin did over the course of 10 months to overcome an unexpected issue that disrupted the relatively smooth running of the program and partially prevented the reusability of New Glenn rocket. A particular difficulty in this regard is Blue Origin's somewhat atypical approach to presenting the performance characteristics of its launch vehicle – in fact, nothing definitive has been officially announced, and remains unannounced, other than target engine thrust values and payload mass. Therefore, rocket assessments can only rely on tentative and approximate data. This contrasts markedly with policy of SpaceX, which, following G. K. Chesterton's covenant, "hide a leaf in the forest, but a corpse on the battlefield", overwhelms observers with typically irrelevant, promotional-type information, carefully concealing key details that are unfavorable to it. However, understanding the principles eliminates the need to know the details, and relying on absolutely reliable facts, on the entire array of data that is relevant to the problem under consideration, as well as on quantitative assessments of the development options of the observed processes, with a high degree of probability one can obtain the most important, qualitative understanding of how the problem that arose before Blue Origin company was solved.

II. Description of events that occurred during two New Glenn's booster flights at intermediate braking phase

During the maiden flight, the first stage of New Glenn rocket (booster), after acceleration and separation from the second stage, continued its ballistic flight until the preliminary braking stage, see Fig. 1, [7], during which speed reduction necessary to reduce thermal and aerodynamic loads on aluminum structure of the booster should have occurred. However, three engines that were supposed to operate during this stage of the flight started with great difficulty – the company stated that they "failed to start properly" [8]. As follows from Fig. 1, which shows three parameters of New Glenn's booster trajectory in time (in seconds): rocket acceleration (in cm/s^2), speed (in m/s) and altitude (in hundreds of meters, acceleration is shown by the purple line, speed – blue, altitude – olive curve), the ignition of these engines occurred within 7 seconds in the time interval of 460 – 467 seconds of the flight. The same follows from the analysis of digital speed data in the additional video window [2].

Only from this point did the sharp increase in absolute value of the "negative" acceleration become noticeable. After this, for another 7 – 8 seconds, up to 475th second, the acceleration, as measured by the digital data, continued to increase slightly in absolute value, obviously due to the booster's reduced mass, until the video stopped showing all the data related to it simultaneously. In Fig. 1, from this point on, horizontal lines are visible on the altitude and velocity graphs, along with zero acceleration values. Consequently, by the 467th second, the engines had reached their operating mode with approximately constant (on average) thrust and remained there for at least 7 seconds. However, as will be shown below, their operation was characterized by certain peculiarities.

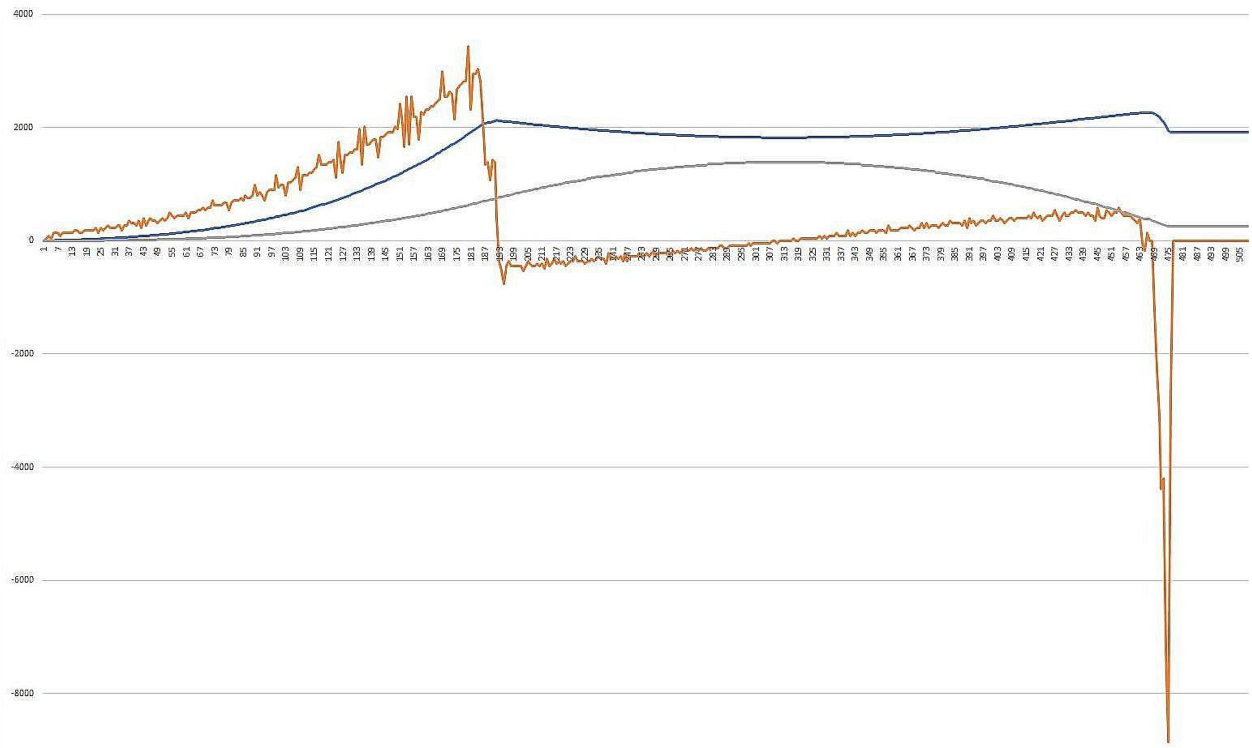

Fig. 1 – Acceleration, speed and flight altitude of New Glenn's booster during the first launch

As usual, when commenting on graphs of this kind, it should be mentioned that due to rotation of the booster around its transverse axis by 180° after separation of the stages, the acceleration, which in Fig. 1 is shown as negative (without taking into account the rotation of coordinate system), presses propellant to the lower bottoms of its tanks, and from a design point of view should be considered as positive, that is, not interfering with operation of the engines.

Video signal stopped 7 seconds after the engines were restarted, and image, which showed jet stream of the working engines, froze on the screen from that moment, see Fig. 2 [2].

As it turned out after processing video data, the acceleration experienced by the booster reached ~ 90 m/s^2, which is at least twice the thrust capabilities of three engines turned on at that moment, see Fig. 1. Thus, it is absolutely clear that at this moment the booster's flight ended in an explosion with a complete loss of functionality, similar to what has happened many times during test flights of Starship system.

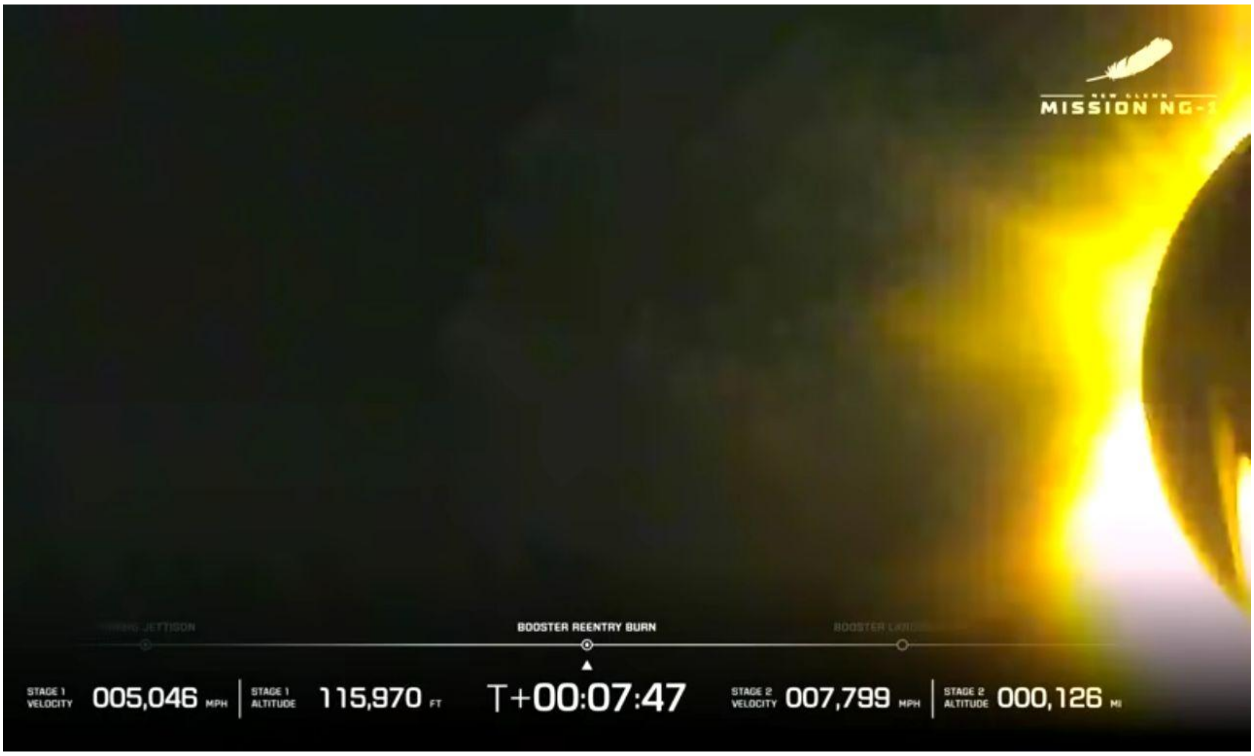

Fig. 2 – The last image of jet stream from booster engines during the first flight, 7 seconds after their re-ignition

During the second flight of New Glenn rocket, there were periodic, rather long failures in the transmission of altitude and speed data, which somewhat complicated interpretation of these parameters and also affected quality of the curves in Fig. 3, which shows the same data for the second flight of New Glenn's booster (see Fig. 3) [9]. The dents present in the curves of Fig. 3 in the interval of 343 – 415 seconds first indicate the time of stopping the acceleration calculation (i.e., the cessation of the transmission of flight speed data), and then their resumption, and dent at the 349th second indicates the time of re-enabling the transmission of altitude data.

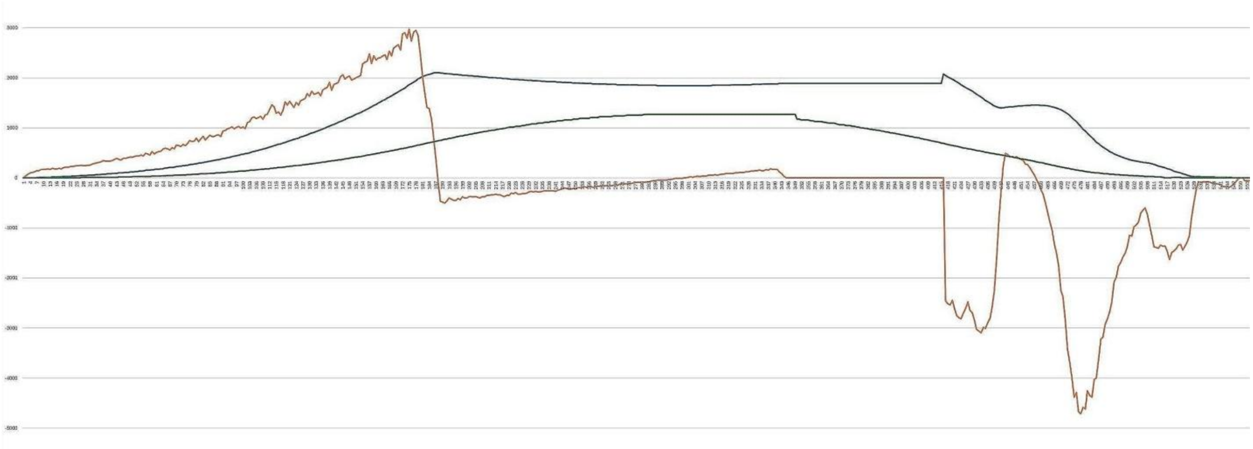

Fig. 3 – Acceleration, speed and flight altitude of New Glenn's booster during the second launch

The reactivation of three engines of booster occurred at 6:55, or 415 seconds into the flight, almost simultaneously with reappearance of velocity data. Therefore, the initial stage of the acceleration change associated with engine activation is depicted in Figure 3 not entirely correct, only as a vertical line segment.

After the intermediate rocket braking, in Fig. 3 peak of aerodynamic braking is clearly visible, followed by rocket braking again – already during landing of the booster.

It's also worth noting that New Glenn trajectories on the first and second flights differed significantly, even before the intermediate braking. For example, booster's maximum altitude was 138 km in January, compared to 127 km in November. This was likely due to optimization of the booster trajectory during insertion of two Escapade small interplanetary probes into L_2 libration point of the Sun-Earth system. However, the differences in trajectory parameters at the start of intermediate braking were much greater. On the first flight, the engines began igniting 460 seconds after liftoff, at an altitude of 43 km and a speed of 2.26 km/sec, while on the second flight, they began igniting 415 seconds later, at an altitude of 69 km and a speed of 2.08 km/sec. This difference is a clear indication that intermediate braking operation on the second flight proceeded completely differently than on the first.

Fig. 4 – Image of engines of booster operating during the second flight, 7 seconds after their ignition

Figure 4 shows an image of the booster during its second flight, 7 seconds after engines ignition, as in Figure 2, which relates to the first flight. Engines operation was displayed only by the faint glow of three dots on its end. At the same time in both cases, the power plants had reached operating modes yet. Of course, the viewing distances and angles of these images are completely different. Furthermore, booster's flight altitude in Figure 4 is 26 km higher than in Figure 2. Nevertheless, such differences in the observed images, as well as the digital data, apparently indicate that the operating modes of the power plants on these flights were different.

III. Booster acceleration and its engines thrust in two flights during the intermediate braking phase

Let us now consider the acceleration and engines thrust during two flights of New Glenn’s booster. We will assume that, at nominal operating conditions, the thrust of its BE-4 engine is 2.45/2.65 MN, and the specific impulse is 3.05/3.30 km/s when operating near the ground and at high altitude, respectively [10, 11].

From Fig. 1 and data in speed window, it is evident that during the first flight, the calculated engine thrust was achieved only 7 seconds after their ignition. According to digital data [2], the decrease in booster's velocity over 7 seconds was 260 m/s, and over the remaining 8 seconds before explosion, it was approximately 340 m/s, so acceleration was equal to 40 ± 2.5 m/s^2. The same value is indicated by the step on the acceleration graph in Fig. 1. In addition to this "inertial" acceleration, the engines had to compensate for the projection of gravity acceleration onto the direction of the flight trajectory, which, according to digital data, was approximately 6 m/s^2 in this section of the trajectory. As a result, the total acceleration was equal to approximately 46 m/s^2, and with full thrust from three engines, mass of the booster during the first flight at the moment of the start of braking was approximately 175 tons.

Similar calculations of booster braking during the second flight in the first 7 – 8 seconds after engine ignition yield acceleration values of 23 m/s^2, while the smaller trajectory inclination resulted in a gravitational component 5 m/s^2, bringing the total acceleration this time to 28 m/s^2. If we reasonably assume that the booster mass at this point was virtually identical in both flights, then the power plant thrust during the second flight was only 60 % of the nominal value. Further calculations of the booster mass reduction based on the change in its characteristic flight speed up to landing showed that landing braking was provided by three BE-4 engines operating at 50 % of the nominal thrust, while in hover mode before landing, the booster mass as the fuel burned out amounted to 120 – 110 tons, a condition that was achieved by operating a single engine at virtually the same throttle ratio of 50 – 45 %. It should be noted that BE-4 engine's thrust can be decreased to 40 % of its nominal value [10]. Therefore, the booster's mass estimate at the start of intermediate braking is fully consistent with its mass estimates during the final phases of flight, hovering, and landing.

It should also be noted that all of these estimates are in complete agreement with the information provided by Blue Origin about final pre-launch test of New Glenn on the ground on October 31, 2025, 13 days before liftoff: "We completed a successful hotfire of our fully integrated New Glenn launch vehicle at LC-36! All seven engines performed nominally with a 38 second duration test including all seven engines operating at 100% thrust for 22 seconds" [12]. Blue Origin CEO Dave Limp wrote that day: "We extended the hotfire duration this time to simulate the landing burn sequence by shutting down the non-gimbaled engines after ramping down to 50 percent thrust, then shutting down the outboard gimbaled engines while ramping the center engine to 80 percent thrust. This helps us understand fluid interactions between active and inactive engine feedlines during landing" [13]. The total thrust of the power plant with 80 % of the thrust of the central engine and 50 % of the two side engines will be exactly 60 %, as was determined by the calculations presented above.

Now we should return to the question of why the engines have started with great difficulty on the first flight, but nevertheless reached 100 % of nominal thrust in 7 seconds, and on the second flight, however, the transition to 80/50 % thrust occurred so quickly that this process was difficult to detect from digital data, although it's the very beginning could have been lost. The obvious reason is that the second engine start occurred 26 km higher than the first, and the flight speeds were similar. Because of change in altitude, the air density, relative to standard atmosphere, decreased by almost 30 times, and the dynamic pressures were 6.4 kPa and 0.18 kPa, respectively [14].

To understand the scale of these values, it should be noted that large subsonic civil aircraft in cruise flight are subject to a dynamic pressure of approximately 10 – 12 kPa, while the typical jet pressure at the nozzle exit of engines designed for operation near the ground is ~ 40 kPa. However, after 7 seconds of flight, the dynamic pressure impinging on the booster during the first flight had already increased to ~ 19 kPa, and then pressure during deceleration could be comparable to the pressure of the jet exiting the nozzle, especially at reduced engine thrust. Of course, during hypersonic flight, a detached shock wave occurs in front of a blunt body such as a booster, which dramatically alters the flow regime around the engine nozzles. However, direct experiments have shown that, at least, BE-4 engines start with difficulty when exposed to a hypersonic flow with a dynamic pressure of approximately 10 kPa. Therefore, starting the rocket braking too low at high flight speed can result in engine failure. However, when the booster engines ignited for final braking at an altitude of 2 km and a speed of approximately 0.245 km/s, the dynamic pressure was ~ 30 kPa, but the engines, judging by external indications, started easily. This may have been due to the booster's angle of attack being still quite high at that point, limiting the flow of external air into the nozzle and therefore not significantly impeding engine restart.

Thus, from the preceding text of this paper, it inevitably follows:

- During the first flight of New Glenn, serious problems with engine ignition occurred during the booster's intermediate braking phase due to too much low initial altitude, but they were still able to start.
- Shortly thereafter, the booster exploded.
- During this phase, three of its engines were operating at nominal mode with 100 % thrust.
- During the second flight, at the same phase, engine ignition occurred without any problems at a significantly higher altitude, and central engine operating at no more than 80 % of nominal thrust, two side engines at up to 50 %.
- With this engine operating mode, the booster's intermediate braking was successful, and it made a planned landing on the ocean platform.
- Explosions similar to one that occurred on the maiden flight of New Glenn, caused by the occurrence of Pogo-type oscillations, have repeatedly occurred on both stages of Starship rocket system, see, for example, [15].
- Blue Origin CEO Dave Limp stated that the pre-launch test of the propulsion system with the above thrust values "helps us understand fluid interactions between active … engine feedlines".
- "The interactions between active engine feedlines" and rocket structure is the cause and source of rockets destructions, usually as a result of explosions, and in such a scenario it is called Pogo.

Thus, the only possible justified conclusion from the analysis carried out can only be the following: in the first flight of New Glenn, during the intermediate braking phase, a catastrophic process occurred and it was Pogo, which was suppressed during the second flight by reducing the thrust of power plant, what is more by different amounts for the central and side engines.

IV. Estimates of possible Pogo frequencies with explanations of not the same degrees of booster engines throttling

Let's now analyze the possibility of Pogo-process on New Glenn's booster when the engines are operating at nominal thrust mode during the intermediate deceleration burn. This requires some data about the booster itself, its engines, and their operating modes. Blue Origin's policy, at least until recently, has been to not disclose almost any such data to the public, except perhaps for the thrust and specific impulse of the engines at nominal operating mode. The deceleration data were obtained in the previous section of this paper. Based on this data, the booster mass on the first flight by the 15th second of deceleration was determined to be approximately 150 tons. Estimates of the remaining necessary data values were obtained by recalculating from the closest analogs for which these data were available.

For example, the most important parameter for further calculations is p_2/p_1, the ratio of the pressure at the rocket engine pump outlet to the pressure at its inlet. For this, naturally, it is necessary to know both of these quantities. The pressure at the pump outlet is a parameter that is rarely indicated in public descriptions of modern rocket engines, but sometimes it is. For example, for an engine with a similar design to the BE-4 with an oxidizing gas generator – the RD-170/171 – the pressure at the oxygen pump outlet in the nominal operating mode is p_2 = 60.2 MPa with a pressure in its main combustion chamber of 25.8 MPa [16]. Based on these data, as well as estimates on first principles of the turbopump power, the pressure at BE-4 oxygen pump outlet was determined as follows: $p_2 \approx$ 30.0 MPa with a pressure in its main combustion chamber of 13.4 MPa [10]. The pump inlet pressure p_1 is determined by tank boost pressure, which is also unknown for New Glenn’s booster. However, in recent decades, pump inlet pressure has typically been in the range of p_1 = 0.3 – 0.4 MPa. Thus, at full thrust, for BE-4 engine's oxygen pump, $p_2/p_1 \approx$ 75 – 100. Other calculated values were obtained similarly.

As more probable, there was considered the possibility of Pogo-type oscillations in oxygen supply channel only. Of course, without precise characteristics of any of the systems needed for the calculations, it's impossible to determine whether a Pogo will occur there or not. However, we find ourselves in a completely different situation. The fact that a catastrophic Pogo occurred during the first flight is an empirical fact. The goal of further calculations is to verify that this process can indeed develop given the booster and its engine parameters, which are at least approximately known from available information or derived from reasonable estimates. In this way, we will rule out so possible scenario: according to our understanding of New Glenn rocket's characteristics, Pogo is completely ruled out, but in reality, it did occur. Then this would mean that our entire system of assumptions is inconsistent with reality. Furthermore, we should verify whether, in this case, differential throttling of the booster's central and side engines is truly required. If this is demonstrated by calculations, it will be possible to conclude that our ideas about the processes that took place are close to reality and qualitatively fully to them correspond.

The frequency of elastic longitudinal own oscillations of the booster hull at the moment of its explosion in the first flight was estimated in exactly the same way as was done previously in the analysis of similar situations in which Starship rocket system or its stages found themselves [17]. The approximate value of this frequency for the case under consideration is $f_e \approx$ 17.6 Hz. Preliminary analysis showed that the frequencies of hydroacoustic oscillations in the oxygen supply lines of BE-4 engines could well be close to half of this frequency, 8.8 Hz, causing the excitation of Pogo-type self-oscillations. Table 1 presents the results of calculating the frequencies of hydroacoustic oscillations for two values of pressure drops on the oxygen pumps at the nominal operating mode of BE-4 engine: p_2/p_1 = 75 and p_2/p_1 = 100 – apparently, for the extreme values of their possible range. The remaining values of this parameter refer to engine operating modes with a thrust of 80 % and 50 % of the nominal value, see Table 1. This approximate calculation example doesn't take into account that when the engine is throttled, the thrust drops somewhat faster than the pressure behind the pump due to a slight decrease in the specific impulse.

Table 1

Rocket Stage Engine	**p_2/p_1**	**L_1 (m)**	**L_2 (m)**	**L_3 (m)**	**L_{eq} (m)**	**f_n (Hz)**
c = 870 m/s						
NG First stage BE-4	75	1.20	2.95	4.15	25.7	**8.45**
	60				23.1	**9.43**
	37.5				18.3	11.9
	75		2.50	3.70	23.7	**9.18**
	60				21.2	10.3
	100	1.00	2.66	3.66	25.8	**8.45**
	80				23.1	**9.43**
	50				18.3	11.9
	100		2.25	3.25	23.7	**9.19**
	80				21.2	10.3

The following notations are used in Table 1: c is the speed of sound in liquid cryogenic oxygen, p_2/p_1 is the degree of pressure increase in the oxygen pump of BE-4 engine, L_1 is the length of the oxygen path from the pump to the gas generator, L_2 is the length of the oxygen path from the tank to the pump, L_3 is their sum, L_{eq} is the equivalent length of the oscillatory circuit, that is, the length that corresponds to the frequency of oscillations that occur in it in the absence of a pump, f_n is the frequency of hydroacoustic oscillations of liquid oxygen in the path.

From experimental data on the occurrence of Pogo in Saturn V rocket [18], it followed that its excitation can be expected if the frequencies of elastic longitudinal vibrations and hydroacoustic oscillations (taking into account the multiplicity) diverge by no more than ± 8.5 %. Therefore, as a test model of a first approximation, it was accepted that a destructive Pogo on New Glenn's booster could occur if the hydroacoustic frequencies are in the range of 8.05 – 9.55 Hz. To conduct numerical experiments using the method described in the work [18], it remains only to determine two parameters: L_1 – the length of the oxygen path from the pump to turbocharger's gas generator and L_2 – the length of the oxygen path from the tank to the pump, where the values of L_1 should be the same for both considered variants of BE-4 engine, and the values of L_2 for the central engine should be smaller due to the convexity of the bottom of the oxygen tank and the greater proximity of this engine to it. In this case, during operation in the nominal mode, the hydroacoustic frequencies of both engines must be within the range specified above, and go outside it when the central engine is throttled to at least 80 % of thrust, and when in the thrust range between 80 % and 50 % for the side engines.

The L_2 lengths of the oxygen tracts of F-1 and J-2 engines of the Saturn V rocket with a first two stages diameter of 10 m, within the thrust range of which BE-4 engine is located, were 2.9 – 3.5 m [18]. It appears that for New Glenn rocket with a diameter of 7 m, the value of $L_2 \approx 2.5$ m is a reasonable estimate. According to available information, the values of $L_1 = 1.0 – 1.2$ m for BE-4 may also be close to reality.

Therefore, for extreme values of the pump pressure drop p_2/p_1 and reasonable values of the lengths L_1 and L_2, two sets of solutions to the equations for the frequencies of hydroacoustic oscillations f_n were constructed that satisfy the requirements described above (see Table 1; Pogo modes are shown in bold). The lengths L_2 were specifically chosen such that the frequencies of hydroacoustic oscillations were practically identical for both sets of solutions. In this table:

- При номинальной тяге возбуждение «пого» происходит в топливных системах обоих типов
- At nominal thrust, Pogo excitation occurs in the fuel systems of both engine types.
- At throttling of up to 80 %, the operation of the central engine (with shorter L_2 length) becomes stable.
- At throttling of up to 50 %, the operation of the side engines (with longer L_2 length) becomes stable also.

Thus, the fact that it was possible to construct at least two variants of this model, with significantly different parameters, demonstrates that the developed model of the phenomenon – Pogo with an explosion during the intermediate braking of New Glenn's booster during the first flight with the engines operating at nominal mode, and the suppression of Pogo during the second flight when the central engine was throttled to 80 % thrust and the side engines when throttled to 50 % thrust – completely explains everything that happened. New Glenn's booster was unable to land during the first launch due to occurrence of Pogo, and during the second launch, Pogo was suppressed by throttling the engines.

V. Road to nowhere: A grueling struggle with a phenomenon that isn't admitted as existing

Last but not least, Pogo suppression by engine control had never been used in the history of fight against Pogo, which began in the fall of 1958 [19], until the third Starship test flight (March 14, 2024). This method has proven very convenient in modern conditions for multi-engine rockets with a wide range of operating thrust. For example, during nine Starship test flights, starting with the third, after Pogo-related accidents on previous flights, SpaceX programmatically reduced engine thrust four times and increased it three times during the previously emergency trajectory phases in order to mismatch the frequencies of elastic longitudinal oscillations of the hull and hydroacoustic oscillations in the fuel systems [15, 20]. Now, obviously, the thrust reduction of New Glenn's booster by Blue Origin has been added to this list to prevent its explosion.

The possibility of using this method of Pogo suppression arose in late spring – early summer of 2023, when author of this article developed an integral theory of hydroacoustic oscillations in fuel supply lines of rocket engines, and performed a large number of calculations, which showed that, for large pressure drops across a rocket engine pump, the oscillation frequency turned out to be inversely proportional to the square root of this drop with high accuracy. In early October 2023, a paper describing the fundamental principles of this theory and the above-mentioned consequence (see article [18]) was submitted to the well-known resource of Cornell University, arXiv.org, where, after an unexpected reversal of initial publication decision and an unprecedentedly long re-examination of this issue for more than a month, it was decided not to publish it. The wording of the decision was as follows: "Our moderators have determined that ... the intended audience for your work is not a community we currently serve" [21]. It would be interesting to know what community they serve after all? Afterwards, this paper was posted on Synerjetics.ru website and became publicly available.

Just four months later, the results of this work were put to practical use during the third flight of Starship system to overcome an acute crisis that had arisen in its test program, and were in the future applied on all subsequent flights. Moreover, a year later, Blue Origin, as seen in the previous text, also used these results – apparently aerospace engineers aren't the community that arXiv.org serves. Oh well, it happens.

The proof that SpaceX engineers didn't spontaneously and in an extremely short timeframe (from mid-January to early March 2024, see [21]) develop the same theory and from it arrive at the above-mentioned relationship, which determined the entire subsequent strategy for testing Starship system, is that each time they introduced a correction to control of its power plant, they only implemented it after Pogo incident had occurred during the previous flight. If they had truly independently developed an integrated theory of hydroacoustic oscillations in the fuel supply lines of rocket engines, they would have been able to determine in advance the conditions under which Pogo is generated. And they wouldn't have had to endure this entire woeful series of successive Starship system crashes, which, with this approach, cannot end until the transitions from one version of the system to the next cease. Moreover, the official policy of SpaceX isn't to acknowledge the existence of such auto-oscillations, at least in the public domain, and to attribute all Starship system crashes to any other random causes, or simply to keep silent about them.

After 11 test flights of two relatively little different versions, SpaceX has yet to even launch a payload into orbit. And no one can say for sure how many more accidents and explosions await us in the future before Starship lands on Mars, or, as now seem far more likely, until the program is shut down. Thus, a paradoxical situation has arisen: what allowed SpaceX to swiftly overcome the crisis of late 2023 and early 2024 has now forced it into a gruelling race of endless test flights of a constantly upgraded system, costing billions of dollars and with an uncertain final outcome. Moreover, the recent events surrounding the ruptured V3 booster, which allowed us to peer into its updated internals, seem already to indicate loss of control over modification process of Starship rocket system. But now is neither the time nor the place to write about this in detail.

It's also worth noting that Blue Origin recently announced plans for permanent upgrades to its recently successfully launched New Glenn rocket, as well as the creation of a significantly heavier version with a larger number of engines [22]. So, perhaps it, too, will embark on this "agile" methodology of blind design, counting on only a finite numbers of mutable grimaces of Pogo in rocket systems that will need to respond to unprecedented amount of challenges from the outside world.

Conclusions

1. During the maiden flight of New Glenn rocket on January 16, 2025, an explosion occurred during the intermediate deceleration phase of the booster, causing its destruction.
2. This explosion was caused by the excitation of Pogo-type oscillation during the operation of three booster engines at nominal mode.
3. Throttling the center engine to 80 % of nominal thrust and the two side engines to 50 % during the second flight on November 13, 2025, suppressed the excitation of this catastrophic process.
4. Method used by Blue Origin to combat this Pogo-process is similar to that already used seven times during Starship test flights.
5. This method is based on the results described in a paper by the author of this work, which was rejected on November 6, 2023, by the moderators of Cornell University resource arXiv.org due to the fact that the target audience of that paper didn't match "a community which this resource currently serves".
6. Isn't it time for the structures that finance this resource to figure out who it serves?

Links

1. New Glenn. *Wikipedia* // https://en.wikipedia.org/wiki/New_Glenn
2. Video. Replay: New Glenn Mission NG-1 Webcast. *Blue Origin* // https://www.youtube.com/watch?v=KXysNxbGdCg
3. J. Roulette – Blue Origin targets late spring for next New Glenn launch after FAA probe. *Reuters*, March 31, 2025 // https://www.reuters.com/business/autos-transportation/blue-origin-targets-late-spring-next-new-glenn-launch-after-faa-probe-2025-03-31/
4. J. Dinner – Blue Origin now targeting mid-October for launch of twin NASA Mars probes on 2nd-ever New Glenn rocket. *Space.com*, September 26, 2025 // https://www.space.com/space-exploration/launches-spacecraft/blue-origin-now-targeting-mid-october-for-launch-of-twin-nasa-mars-probes-on-2nd-ever-new-glenn-rocket
5. Video. Replay: New Glenn Mission NG-2 Webcast. *Blue Origin* // https://www.youtube.com/watch?v=ecfxcTEl-1I
6. New Shepard. *Wikipedia* // https://en.wikipedia.org/wiki/New_Shepard
7. OneSpeed – Re: New Glenn flight 1: Blue Ring tech demo: 16 January 2025, *NASASPACEFLIGHT* // https://forum.nasaspaceflight.com/index.php?topic=62178.msg2657041#msg2657041
8. J. Foust – Investigation into failed New Glenn landing completed. *SpaceNews*, March 31, 2025 // https://spacenews.com/investigation-into-failed-new-glenn-landing-completed/#:~:text=%E2%80%9CThe%20final%20mishap%20report%20identified,FAA%20said%20in%20its%20statement.
9. OneSpeed – Re: New Glenn Flt2: EscaPADE A/B: CCSFS LC-36B : 13 Nov 2025, *NASASPACEFLIGHT* // https://forum.nasaspaceflight.com/index.php?topic=63815.msg2735610#msg2735610

10. BE-4. *Wikipedia* // https://en.wikipedia.org/wiki/BE-4
11. ZachF – Re: Raptor vs. BE4 Thread: 08 January 2024, *NASASPACEFLIGHT* // https://forum.nasaspaceflight.com/index.php?topic=47513.msg2556268#msg2556268
12. Blue Origin – @blueorigin, *X-Post*, 31 October 2025 // https://x.com/blueorigin/status/1984096485961613559
13. D. Limp – @davill, *X-Post*, 31 October 2025 // https://x.com/davill/status/1984094714283585842
14. 1976 Standard Atmosphere Calculator // https://www.digitaldutch.com/atmoscalc/
15. Yu. I. Lobanovsky – Second crisis of Starship program. *Synerjetics Group*, 30.03.2025, 11 p. // https://www.synerjetics.ru/article/second_crisis_eng.htm
16. LRE RD-170 (11D521) and RD-171 (11D520). *Liquid Propellant Rocket Engines* // http://www.lpre.de/energomash/RD-170/index.htm
17. Yu. I. Lobanovsky – Causes of Starship both stages crashes on second flight. *Synerjetics Group*, 04.12. 2023, 10 p. // http://www.synerjetics.ru/article/second_flight_eng.htm
18. Yu. I. Lobanovsky – Cause of Starship crash on first flight. *Synerjetics Group*, 05.10.2023, 19 p. // http://www.synerjetics.ru/article/starship_crash_eng.htm
19. B. I. Rabinovich – Instability of liquid-propellant rockets and spacecraft and some fragments of the history of combating it. *Preprint IKI RAS*, 2006, 40 p. // http://www.iki.rssi.ru/books/2006rabinovich.pdf
20. Yu. I. Lobanovsky – Why did Starship second stage not explode in the ninth flight, but instead began to spin uncontrollably? *Synerjetics Group*, 15.05.2025, 10 p. // http://www.synerjetics.ru/article/ninth_flight_eng.htm
21. Yu. I. Lobanovsky – Paradox of Starship two flights and its resolution. *Synerjetics Group*, 30.03.2024, 16 p. // http://www.synerjetics.ru/article/paradox_eng.htm
22. Upgraded Engines and Subcooled Components Drive Enhanced Performance. *New Glenn Update, Blue Origin*, November 20, 2025 // https://www.blueorigin.com/news/new-glenn-upgraded-engines-subcooled-components-drive-enhanced-performance

Moscow
30.11.2025

Yu. I. Lobanovsky