NARRATOR: Rocket and spacecraft designers build some of the most complex machinery imaginable and make it work in metal-melting heat and absolute cold.

Their vehicles have to keep their occupants alive in a vacuum and as they plunge into thick air.

Out of all the situations engineers plan for, one of the most challenging things to do is come up with a safe system to rescue a crew and spacecraft from a failing rocket just before it launches or as it soars through the atmosphere at speeds approaching Mach 25.

It's called a launch abort system. Just as a fighter pilot has an ejection seat to lift him out of a crashing airplane, a launch abort system, or LAS, lifts a spacecraft away from a rocket that is suffering a catastrophic failure.

GERACE: A launch abort system is basically, you can think of it as a smaller rocket that's been integrated into the launch vehicle to get the crew off in case of an emergency.

What that really enables you to do is you're really taking the safety, the overall safety, of the system up in order of magnitude. It's a much more effective way to spend your money than just rolling that back into a more reliable launch vehicle. I mean, you want a reliable launch
vehicle, no doubt about it, but a reliable abort system combined gives you a much more safe system.

Cheryl Malloy: We often talk about the philosophy of a robotic mission or a defense mission always presses to orbit. In the case of human spaceflight, if something's going wrong with the rocket or the spacecraft, we need to abort and bring that crew home safely.

It's a very basic definition of how we have to change how we're thinking about human spaceflight.

NARRATOR: What makes designing an LAS difficult is that it has to work in a lot of different environments, sometimes automatically, sometimes on command from the astronauts or ground controllers.

GERACE: So, an abort system has to be able to account for a wide range of scenarios that might go wrong in a launch vehicle. Some of those things, like a loss of thrust, your engines shut down, those are actually fairly benign situations that give you a fair amount of time to react and get off the launch vehicle. Other situations, a tank exploding, or something like that,
you've got to get off the rocket just like that. In literally milliseconds.

NARRATOR: A team of NASA engineers are working closely with aerospace companies under the agency's Commercial Crew Program to outfit their designs with an effective escape system.

NASA is not designing specific systems for them, but has written a list of requirements companies must meet if the craft is chosen to carry the agency's astronauts.

GERACE: We actually had a lot of things that we could draw on for a basis for requirements when we started this development process. Of course NASA has an enormous amount of experience in manned spaceflight. And so, that technical experience really provided the bedrock for the knowledge of what we needed from a requirements standpoint. There was also a fair amount of experience that we had developing a similar system with the OSP Program, Orbital Space Plane, several years ago and that helped us guide these requirements as well.

We also are looking at our primary stakeholders, such as ISS, the International Space Station.

The mission is to get our crew to the space station and back and so their needs drove a lot of our requirements as well.
Abort systems have been an integral part of NASA spacecraft since

Alan Shepard's launch on May 5, 1961.

A small rocket on top of his capsule would've fired to lift the spacecraft and Shepard away from the Redstone booster if anything had gone wrong.

The Apollo Program used the same concept, called a tractor rocket, for its design.

In fact, the rocket on top of the capsule was more powerful than the main booster that lifted Shepard.

Now, the companies working with NASA are incorporating technological advances into their own designs.

GERACE: The Apollo rocket, as you know, incorporated what we call a tractor puller,

which had the smaller rocket on a tower above the spacecraft, and that's really advantageous for a couple of areas.

Which, from a control standpoint, it's much easier to design a control system to control that during an abort. Also, you can put more powerful rockets, solid rocket motors up there away from the actual capsule. Now, a pusher motor is the other type of abort system that is being
developed and that has some advantages as well. It tends to be more synergistic with the overall architecture because if you don't have an abort, which most of the time you wouldn't, you can use those propellants for other parts of your mission design. And that enables your overall design to be more effective and efficient.

This work is a unique challenge to NASA engineers who have not designed a new spacecraft since the space shuttle, which began flying in 1981. My background is the Launch Services Program. We've launched missions to Mars, to Pluto and that has been enormously exciting as well. But this is manned spaceflight. And this is an opportunity for us as a country to be able to bring back the capability that we lost when we retired the shuttle to take our astronauts to low Earth orbit and be able to be part of that is just an exciting aspect. There's so many challenges but the end goal out there is really an exciting opportunity.