

Lessons Learned Entry 5479 Flex Hoses Pete Brinko video text

MICHAEL: Pete, can you talk to me about the Flex Hose problem and how you found out about it?

PETE: Well, we had the problem for years. I'm sure that looking back we found out that it was there but it didn't really come to light, didn't really get a lot of attention until we had a two week delay in the STS-113 launch where we were sitting late in the count and, we monitored for oxygen content in the mid-body and all of a sudden we got a spike and we didn't understand it so we stopped and it turns out it we had a Flex Hose (that was an oxygen hose), part of the crew supply oxygen that had developed a leak, of course we stopped and replaced the hose and as I said it caused a couple of weeks down time and then we were able to launch but, it kicked off a big investigation. This was in 2002... which was right before the Columbia accident which happened in early in 2003, February, February 1st but -- that whole time that we were down we were working hard to try and get an idea of the extent of the problem. What we had to do to get flight rational cause there are a lot of Flex Hoses in the ship.

MICHAEL: So this is a pretty important problem or situation.

PETE: Yeah, it can be, when we looked back and found other failures, every failure we had was on the ground including this one. But this one was the closest we had to having one in flight and you wouldn't want to have that in flight because, you know we have redundant systems, you know (it) definitely would shorten missions and some cases,... would be --- I'm sure pretty traumatic to the crew and in all cases you want to avoid that if possible. We have to assure everyone that we are good to fly, and the hoses that we had were not going to have a problem in flight.

MICHAEL: So what were the mitigating actions, how do we fix the problem?

PETE: We found out after much failure analysis and attempts to understand the problem and the extent of the problem that there were several different aspects of these metal bellows Flex Hoses that you had to pay attention to, one was how tightly they were bent, which was the minimum bend radius requirement. In this case where the hose failed it was collateral damage, really that is what it boiled down to, collateral damage, which is damaged caused by human beings in the process of doing their work, just bumping up against the hose and pushing it back and forth enough times, you know this reverse bending will cause the hose, the inner hose which is in the metal bellows in this case this particular type of hoses, would cause it to crack and eventually open up and leak.

MICHAEL: Ok. So Pete what would you recommend to designers of future vehicles?

PETE: Well they are going to have to pay attention to all the requirements that you have to adhere to with these hoses, and we found in a lot of cases that the hoses did not comply within the bend radius, and we wound up taking those hoses out or they were routed in such a way that they caused the hose to bulge or there was a twist in the hose which is also something that can cause you problems in the long run with the design. They needed to consider when you do qualification testing, which is done on any kind of flight hardware for spacecraft applications, that you have to consider what happens on the

ground not just with the application in flight but on the ground there's going to be handling, there's going to be storage, there's going to be this type of collateral damage just because of the work that is done on the craft and in the case of the shuttle, there were multiple missions, that was a bigger problem because there was more of that going on.

MICHAEL: Well great, was there anything else noteworthy about the Flex Hose situation you would like to discuss?

PETE: I don't think so, other than, if you are able to use something besides the Flex Hose, which is something we found out in part of the investigation was, in cases where you can put a hard line in. Hard lines can be bent in such a way to take up for some vibration affects. That's what we did, we replaced several of the Flex Hoses that went to the water tanks were hard lined. Anytime you can avoid, I mean it's good to have metal bellows Flex Hoses, their good for lots of applications and they'll continue to be used but if you can avoid using them do so. If you do use them make sure that if they are being used for extension or retraction... and most of the hoses were not, they were just in place for vibration considerations, and routing, and... for cases were you had to disconnect and reconnect. We had some hoses in the ECLS system for the Freon loops that did extend and retract with the radiator doors in the payload bay doors which had the radiator panels on them. We found out from testing that they would have failed in less than a hundred missions that they were qualified for, and they had a reverse bending problem because of the end of their cycle they bent over a little further than anyone really realized. So you have to consider everything especially with the hose that does extend and retract.

MICHAEL: Well Pete, thank you very much for sharing your knowledge and giving us this time.

PETE: Your welcome.