Mark,

Per our conversation, I am sending you this letter. As we discussed, at this point I must stay anonymous. The fluid control industry is a “small village”. Let us just say, I am a professional in the valve industry.

The point of this letter is to draw attention to certain aspects of seals, valves and actuators that must be part of any artificial environment to maintain life and functionality. I have no special knowledge of the ISS but there are principles of fluid and motion control that cannot be ignored. We assume that the ISS has supply systems for water, fuel, air, etc. These systems would all require valves, pumps, and seals at a bare minimum. Without systems to deliver, send, expel, vent, filter, and store these fluids and gases, life on board would be impossible. Tubing, pumps, tanks and valves would need to be present across all of the living areas to assure (at the least) fresh air. Seals (such as O-rings) would be required throughout the ISS to hold in gases and fluids. Valves would be required to meter these gases and fluids and to maintain proper pressures. Actuators would be required to move devices, such as the Canadian arm, hatch openings, etc. Anything that is not moved manually requires an actuator.

Let look at some of the questions that pose a problem:

Seals-

For aerospace applications, the most commonly used seals and o-ring materials are GLT-type fluorocarbons (generically, ASTM D1418 Type 3 elastomers), which have a glass transition temperature of -30°C. Materials of this type that meet the new AMS 7287 and predecessor AMS-R-83485 specifications have a useful operating temperature down to -40°F and up to 400°F. Even though this is an impressive temperature range, it appears that the ISS is being exposed to temperatures beyond this range. There are special Teflon based seals available that can extend a little past this range but they are not made with flexible or compressible materials. Therefore, the mating components would have to be manufactured within a millionth of an inch tolerance to prevent a seal from moving and thus leaking. Not convenient for a hatch or a fuel valve that is in constant use. Perhaps the seals are shielded from the temperature changes. Perhaps, but the outside of the ISS does not seem to show the insulation units required to accomplish this. Another problem with seals is that they wear out. Seals would have to be replaced frequently. Preventive maintenance of seals and sealing surfaces would keep a maintenance team busy 24 hrs.a day. Seal replacement would require sealing off areas, cleaning of the sealing surfaces (since in many cases a human hair can cause a seal to leak), lubrication, polishing sealing surfaces or replacement of modules, etc. I do not think any of these things have been observed on the ISS. Seals also require backpressure to seal. I have no idea how a seal would function against a vacuum. We have no calculation for it. Any seal that I have ever seen would simply be sucked out in to space. How fuel, air, water, etc. are are contained and moved in the ISS? I have no idea. The seals of the ISS must be flawless, maintenance free, immune to temperature changes, miracles of modern science. We in the industry would hold such mythical seals in awe and reverence if they existed.

Valves-

Valve would be needed aboard the ISS for many life sustaining reasons, fuel, air, water, ammonia, etc

From www.Space.com

"The International Space Station's active thermal control systems (ATCS) pump fluids through closed-loop pipes. A liquid-ammonia coolant loop along the station's main truss keeps the station's electricity-generating solar panels cool.

An ammonia pump on the main truss failed in 2010 and had to be replaced by spacewalking astronauts. The Expedition 35 crew on the International Space Station reported an ammonia leak near the same location on May 9, 2013.

Liquid ammonia circulates through the pipes, carrying waste heat from the solar panels to the photovoltaic radiator panels, where the heat escapes into space. This keeps the solar panels cool."

So there it is the ammonia is pumped. Pumping requires valves. What valve can function in extreme temperatures in a vacuum? Since a spacewalk was required to "repair" the unit, it is obviously exposed to the vacuum of space. The seal issue mentioned above would be a major problem. How would they perform Degaussing (the process of decreasing or eliminating a remnant magnetic field.) of the valve for it to function properly since they are never grounded? When these astronauts replaced the pump how was this accomplished without depressurizing the entire ammonia supply? How does one do that in a vacuum? I watched this procedure on Space.com. It was clearly done underwater. Plastic pieces floated upwards, etc. No residual ammonia in the broken pump was emitted, no lubrication applied, the list goes on. Valves require venting. Excess pressure has to go somewhere. Is it vented into space? Would that not suck all the gasses and fluids out into the vacuum of space, since there is no backpressure in space? Are gas valves vented to the interior of the space station increasing pressure in the living areas to dangerous levels? Valves require filtering. Are filters changed frequently? Are there three maintenance teams working 24/7 to maintain the filters, because if a filter fails and stops a valve, it could kill everyone on board? Consider a commercial airliner. Consider how much maintenance one airliner needs to stay in the air. Think about the fuel pumps, the air exchange, and the seal replacement programs. Valves are maintained and changed out frequently. Now consider the ISS in this light. One little pumps change out in 2010 and a little repair in 2013? Does NASA have valves that function in impossible environments and seals made of un-obtainium and unicorn tears? I am guessing… no.

Actuators (air cylinders)-

Actuators (or air cylinders) are the muscles of moving machinery. Pumps are the hearts of machinery that pump fluids and gases to drive the machines. Valves control the pressures and quantities of the fluids and gases. Actuators push and pull to give the machines movement. They have been used for decades to drive the industrial revolution forward. They are the muscles of robots that move their limbs. They hold the hood open on your car so you can check the oil. They open and close the hatches on submarines. They drive needles that weave carpets. They are all around us in every mechanical system. Some are driven with pneumatic air pressure, some use hydraulic fluids and some are electrical. Let us look at the types.

Pneumatic (air driven) – On the ISS how would these work? The seal issue is certainly a big problem. Actuators need valves. We covered these problems already. Piston rods rely on dynamic seals and are prone to leakage. Temperature is an issue. Ice cream makers and metal forges struggle with actuators due to the extreme temperatures that they deal with, but consider that they only deal with their end of the temperature range. Ice cream makers deal only with extreme cold. Metal forges deal with only extreme heat. What kind of Vulcan technology is NASA using to handle both temperature extremes, let alone in a vacuum?

Hydraulic (fluid driven) – The same problems as Pneumatic s apply here as well. In addition, Hydraulic actuators drip and “weep” oil. The ISS would become uninhabitable without constant maintenance. Where would the fluid be stored, disposed of, replaced, etc.

Electronic - This is probably the most probable type NASA would claim that they use. They are clean and function without the exchange of pressurized substances. What about maintenance, Lubrication, degaussing, replacing motors, drives, belts, circuits, panels? Certainly they would be prone to shorting out and requiring constant care, especially since they cannot be grounded (consider satellites, but that’s another topic). Changing out components is not like changing the brush heads on a vacuum cleaner.

Maintenance and installation -

Lastly and probably the most important problem, <u>no machine shop</u>.

All dynamic systems require installation and maintenance. No matter how carefully designed and how advanced a system is, something will require machining. All large Navy craft have onboard machine shops. The reason that I use ships and subs as examples is that they are the most similar systems to the ISS that we can relate. They are moving, large, self contained and functioning in hostile environments. Navy vessels must be able to repair, modify or replace anything onboard. Even under the best conditions, metal will warp, screw threads will strip out, seals will leak, welds will break, metal sealing surfaces will get scratched, tubes will crack, electronics will short out, motors will overheat, motors will freeze up, critical tools will break, belts will break, cables will snap, etc., etc, etc, ad infinitum. The ISS appears to not have a machine shop what so ever. How are repairs done? Are we to believe that all the replacement parts are flawless modules that snap together perfectly every time like Legos? Are there sea containers full of replacements parts floating next door? Is there never a time that a critical threaded hole is stripped out and needs to be re-tapped? Do parts never warp in the extreme temperatures and need to be re-surfaced? Is there welding equipment up there? Submarines have welding equipment. They can even weld underwater. What happens in the event of a structural event that requires welding? I know that Captain Kirk and Spock repaired the Enterprise using a Phazer as a welder, but this is supposed to be real. Of course, the chance of fire is too great to weld, but structural damage happens and has to be calculated into the plan. As far as I know, it is not. Regarding fire hazards, machine shops throw sparks, lots of sparks. Even if you could haul a lathe, Bridgeport and drill press up to the ISS the danger would be too extreme. This is where NASA "shot themselves in the foot". For short missions (days, even weeks) this would not be an issue, but when missions are years long….uh no.

The ISS is great theater but not reality.

Thank you

The Valve Guy