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**From:** PAS

**Project:** Plasma Arc Speaker

**Subject:** Possible Failure Modes

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Failure modes for the plasma arc speaker are analyzed using the mechanical and electrical failure mode taxonomies. Failure modes related to the speaker included stress rupture, surface fatigue, thermal fatigue, brittle fracture, spalling, surface fatigue wear, glow discharge, electric field coupling, electromagnetic radiation, ground bounce, and electrical overstress (EOS). Failure modes are ranked from 1 to 5 for likelihood with 1 being highly unlikely and 5 being most certainly to occur. The consequence of failure is also ranked from 1 to 5, with 1 being minor and not expected to affect performance, and 5 being very high and definitely affecting safe operation.

The mechanical failures with the highest likelihood were stress rupture, surface fatigue, and brittle fracture. Stress rupture and brittle fracture focus on the top and bottom arms, used to raise and lower the electrodes, breaking into two pieces due to stresses on the arms. The consequence for these failures is complete failure of operation because the electrodes are no longer supported and sound is not produced. The surface fatigue failure is the failure of the rack and pinion due to cyclical fatigue. The consequence of this failure does not result in total failure because the electrodes are still supported but unable to raise and lower for sound optimization.

The most likely electrical failures, while there are probably many more outside of the scope of the electrical taxonomies, are glow discharge, electric field coupling, and electromagnetic radiation. Glow discharge is an effect already being dealt with in the design process which is the heating up of electrodes and the melting and/or vaporization of metal. The levels of heat created have yet to melt or vaporize metal in testing (to our knowledge), but previous products have melted electrodes. Consequences of this melting are minimal unless the speaker is continuously operated at high heats and melted, an ill-advised move.

Electric field coupling and electromagnetic radiation go hand in hand with each other for this speaker since it operates at high voltage and high frequency, both resulting in interference with electrical objects. The consequence for these actions is also the same, causing dissatisfaction with other electrical devices around the plasma arc, unless the arc is optimized. Optimization lowers the chance of interference.

The mechanical failure modes caused Team PAS to minimally rethink the product design. The design has already been finalized and the only way to improve the final design to prevent these mechanical failures is to use different material, but the resources for the speaker are limited to rapid prototype material. Electrical failure modes are mostly in the hands of the electrical engineering team and several of the listed concerns in the table are being, or have been, addressed in the design.