The Lee Company

MTBF Analysis of IEPA Series Solenoid Valve

March 21, 2019

Revision: A

Changes: Initial Release

Approval:

    Originator- GAR 03/21/2019

    Group Head –DJS 03/21/2019

    REVISION STATUS

Sheet	Revision	Date	Written By	Approved By	Description
1-3	A	03/21/2019	T. Ruth	D. Schweitzer	Initial Release

Failure Modes and Effects Analysis
IEPA Series Valves
2-Way Normally Closed Solenoid Valve

Entry	Component Description	Component Function	Failure Mode	Failure Cause	Failure Rate (per E6 hrs)	Quantity of Parts	Failure Effect	Source
1	Housing Assembly	Retains and positions internal valve details	Deformation	Excessive pressure, mechanical impact	0.010	1	Failure to actuate or turn off	T1062 Rev A
			Rupture	Excessive pressure, mechanical impact			Loss of system pressure	
2	Compression Spring	Bias the poppet seal against the seat to prevent flow	Broken coil	Excessive stress, corrosion	0.005	1	Unable to block off ports, excessive leakage	T1062 Rev A
3	Poppet Assembly	Moves the seal onto and off the seat to open and close a flow path	The poppet Does not move	Contamination, corrosion	.053	1	Failure to actuate or turn off	RAIC NPRD-2011
			Damaged elastomer	Contamination, Excessive Pressure			Leakage and loss of pressure	
4	Cover/seat Assembly	Provides the means to prevent or allow flow between the inlet and outlet ports	Damaged seat	Contamination wear, mechanical wear, erosion.	0.100	1	Leakage, reduced flow	T1062 Rev A
5	Shield	Protect the coil, creates an epoxy potting form, and completes the magnetic circuit	Deformation	Mechanical impact, corrosion	.053	1	Valve will not actuate, leakage, loss of pressure	RAIC NPRD-2011

6	Potting Epoxy	Insulates magnet wire from bobbin, prevents movement, dissipates heat	Short circuit	Temperature damage, poor potting	0.004	1	Valve will not actuate	T1062 Rev A
7	Flux washers	Creates a magnetic path to increase pull force	Loss of magnetic properties	Corrosion	.026	2	Valve will not actuate	RAIC NPRD-2011 (hardware)
8	Electrical Coil Assembly	Creates a magnetic field to pull the seal away from the seat	Open circuit	Vibration and/or temperature damage, corrosion, break in wire insulation, poor solder joint	.13	1	Valve will not actuate	RAIC NPRD-2011
			Short circuit	Vibration and/or temperature damage, corrosion, break in wire insulation, poor solder joint				
			Intermittent continuity	Vibration and/or temperature damage, corrosion, break in wire insulation, poor solder joint				
					.407	9		

MEAN TIME BETWEEN FAILURE

Assuming the above components are all in series, the total failure rate (αt) for the solenoid valve assembly is the sum of the individual component failure rates. Thus, $\alpha t = .407 \times 10^{-6}$ and, by the exponential method:

MTBF=1/Total Failure Rate

MTBF = 1/αt =2,457,000 Hours

* These values for **MTBF** are approximate. They have been partially based on qualification test results, customer returns, and Reliability Analysis Center document "Nonelectric Parts Reliability Data 1991/2011 (NPRD-91/2011) and Electronic Parts Reliability Data 2014 (EPRD-2014). History has shown that with the high confidence level employed here that the **MTBF** calculations tend to be conservative. Therefore, the actual **MTBF** is expected to exceed the estimates.