FAILURE MODE EFFECT ANALYSIS FOR RAPID MIXER GRANULATOR

Revision	Date	Reason for revision
00		First issue

FAILURE MODE EFFECT ANALYSIS FOR RMG

PREPARED BY	DESIGNATION	SIGNATURE /DATE

CHECKED BY	DESIGNATION	SIGNATURE /DATE

APPROVED BY	DESIGNATION	SIGNATURE /DATE

S. No.	Document Title	Document Number
1.	Validation master plan	
2.	Project validation plan	

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Name (block letters)	Function	Signature

Level	Descriptor	Example detail description
1	Unlikely	May occur at some time
2	Possible	Might occur at some time
3	Likely	Will probably occur in most circumstances

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Level	Descriptor	Example detail description
1	Minor	• No impact on the product quality or outcome of the equipment. • Features required for easing equipment operation.
		• No direct impact on product quality/ outcome of equipment. however may indirectly affect the product quality.
2	Moderate	• Minor effect on personnel health • Used in the initial stage of operation, however it may affect the final output but those are not used for final release of output. • Effect on environment such as clean room.
3	Major	• Features having direct impact on product quality/ outcome of equipment like contact parts MOC, Surface finish, Control system, Process air quality etc. • Failure could lead to regulatory non-compliance. • Loss/ damage to equipment or its critical sub-components • Critical instruments not calibrated or not of desired range or accuracy. • Proper supporting documentation not provided. • Major effect on personnel health

Based on the above parameters of likelihood and consequence a qualitative risk analysis matrix is prepared to identify the overall Level of Risk, as mentioned in table below.

Qualitative risk analysis matrix – level of risk*

The final Risk level shall thus be described using descriptors such as “Low”, “Medium” & “High”, where each descriptor implies the following meaning:

Low – Risk can be accepted or ignored. These do not affect the final quality of the equipment/ system and it can be managed by routine procedures and are unlikely to need specific application of resources.

Medium – Risk required ongoing monitoring and review, to ensure level of risk does not increase. Otherwise managed by routine procedures.

High – Action plans must be developed, with clear assignments of individual responsibilities and timeframes.

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Likelihood	Consequences/ Impact		
	1 – Minor	2 – Moderate	3 – Major
1 (Unlikely)	Low	Medium	High
2 (Possible)	Low	Medium	High
3 (Likely)	Medium	High	High

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								Mitigation Method	Residual risk level	Verification
Charging										
1.	Transfer of material	Transfer of material into RMG bowl is difficult	Yes	Spillage due to complicated manual transfer	EHS	Product exposure	Medium	• Suitable method of material transfer will be considered to avoid spillage. • Operator shall wear the PPE to avoid the contact with product.	Acceptable	IQ/SOP
2.	Addition of binder	Binder cannot be added during running process	Yes	Process requirement	No	NA	High	Charging port with grill will be provided to add the binder and to assess the process including assessment of granulation end point.	Acceptable	IQ
3.	Charging of thick paste binder	Addition of less quantity of binder due to incomplete transfer	Yes	It will lead to inadequate granulation	No	NA	High	Manual transfer system shall be considered.	Acceptable	SOP
Process										
4.	Speed of Impeller and chopper	Speed of the impeller cannot be controlled	Yes	Process requirement	No	NA	High	There should be provision to select low/high speed with the help of selector switch.	Acceptable	IQ/OQ

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5.	Chopper	Height of chopper is not suitable with operation	Yes	Lumps produced during granulation may not be treated and proper granulation may not be achieved	No	NA	High	The location of the chopper should be designed for its effective performance.	Acceptable	IQ/OQ
6.	Shaft	• Sealing is poor. • Sealing material is not suitable.	Yes	It will contaminate the product	No	NA	High	• Sealing shall be mechanical and shall be effective, robust and detectable so as to ensure the same. • MOC should be food grade.	Acceptable	IQ
7.	Mixing bowl	Bowl is not leak proof	Yes	Material may spill out	EHS/ Operational	Operator protection. Product loss	High	A leak proof joint is considered by gasket sealing.	Acceptable	IQ/OQ
8.	Process control	Process parameters could not be monitored and controlled	Yes	Process requirement	No	NA	High	All the process related parameter shall be controlled by the control panel of the equipment	Acceptable	IQ/OQ

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9.	Mixing	Formation of dead zones	Yes	It will lead to inconsistent mixing	No	NA	High	The equipment will be designed so as to cover processing material over entire periphery of the RMG bowl for proper mixing.	Acceptable	IQ/ OQ
10.	Machine operation	Operator cannot operate the machine	Yes	Process parameters cannot be achieved	Productivity	Machine cannot be operated	High	Proper training to be provided to concern person for setting and operation of machine	Acceptable	OQ
Discharge										
11.	Discharge	Granules cannot be transferred manually	Yes	Basic requirement	No	NA	High	• RMG agitator will force the raw material towards discharge port from where granules will be transferred to FBD bowl. • Discharge port will be designed for direct unloading of processed material into FBD bowl.	Acceptable	IQ/ OQ
12.	Discharge arrangement	Discharge port is not leak proof	Yes	.Contamination of the area Yield loss due to leakage during mixing	EHS/ operational	Product exposure. Product loss	High	Discharge valve will be designed leak proof so as to eliminate risk of powder spillage.	Acceptable	IQ/OQ

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Cleaning and Material of Construction:										
13.	Cleaning	Improper cleaning	Yes	Accumulation of particles leading to Inefficient cleaning process	No	NA	High	▪ Proper cleaning method has to be provisioned. ▪ All gaskets provided to avoid leakage should be amenable for easy removal & re- fixing for cleaning. ▪ All bolts, nuts on the exterior part of the equipment shall be provided with cap head or cap nut.	Acceptable	IQ/ OQ
14.	Cleaning	Difficulty in cleaning	Yes	Chances of contamination. Parts need to be dissembled for proper cleaning	No	NA	Medium	▪ The design shall ensure adequate clean ability (smooth, crevice free surface, MOC SS316 or better surface). ▪ Parts that cannot be cleaned in mounted position eg. Vent filter, to be made suitable to dissemble and clean.	Acceptable	IQ / OQ

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15.	Cleaning	During cleaning water spray is not reachable to all parts of bowl like nozzles of material charging, etc.	Yes	Cross contamination however for effective cleaning other alternatives can be opted.	No	NA	High	• Agitation with full brim water within bowl is the alternative. Lid can be opened and remote surfaces can be cleaned manually.	Acceptable	IQ/OQ
16.	Material of Construction	▪ Surface and construction of the machine is not compatible to product. ▪ Material reacts with cleaning media like PW, IPA etc.	Yes	It will lead to product contamination due to corrosion	No	NA	High	▪ All product contact metallic surfaces should be of SS 316 or better. ▪ All welds and joints shall be ground finish; metallic surface will have no crevices. ▪ Non Contact surfaces should be SS304 with external surface matt finish.	Acceptable	IQ
17.	Welding	Welding quality not sufficient (Piping)	Yes	GMP requirement; Cleaning problems, surface conditions out of specification in case of bad welding quality.	No	NA	High	Standard welding technique: Orbital welding Welding verification reports shall be available	Acceptable	IQ

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18.	Gaskets, seals and O rings MOC	Gasket MOC not compatible with material handled in equipment or decontaminating agents	Yes	▪ Product contamination possible	No	NA	High	▪ All gaskets must be inert in nature to product. ▪ MOC should be food grade (Silicon/PTFE).	Acceptable	IQ
19.	Surface Finishing	Surface Finishing of Internal & external surface insufficient	Yes	▪ GMP requirement; cleaning problems. ▪ Micro-organisms may accumulate on metallic surfaces	No	NA	High	▪ Surface roughness, Ra ≤ 0.4 µm, proven by certificates for internal surface. ▪ Crevice free smooth, rounded corners & smooth surface.	Acceptable	IQ
Safety										
20.	Power	Power recovery is not warned	No	NA	EHS	Staff protection	Medium	▪ Equipment starts with human intervention only, ▪ Process should start from the step it stopped.	Acceptable	OQ
21.	Noise level	More noise is produced by the equipment during the operation	No	NA	EHS	High noise may cause deafness and anxiety	Medium	Noise level shall be below 80 db at a distance of 1 m from the equipment.	Acceptable	OQ
22.	Emergency stop	Emergency stop not provided	No	NA	EHS	It may lead to accident	High	Emergency stop function on accessible area.	Acceptable	IQ/OQ

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23.	Closure of the rotating & electrical parts	Appropriate closure of the rotating & electrical parts is not provided.	No	NA	EHS	It may lead to accident	High	Appropriate closure of all the rotating & electrical parts.	Acceptable	IQ
Instrumentation and controlling										
24.	Timer	Running process time cannot be adjusted / selected	Yes	May lead to insufficient granulation	No	NA	High	Process timer shall be installed to measure and record the process time.	Acceptable	IQ / OQ
25.	Speed	RPM of Chopper / impeller cannot be adjusted	Yes	Granulation would not be completed	No	NA	High	Speed /RPM can be adjusted by speed regulator pot /switch.	Acceptable	IQ / OQ
26.	Control panel	Controlling of process / equipment not possible	Yes	Controls all critical process	No	NA	High	Control panel/ relay shall be provided to control all process related parameter and to ensure effectiveness of process.	Acceptable	IQ / OQ
Utility										

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27.	Compressed air	Pressure of compressed air inadequate	Yes	Improper cleaning	No	NA	High	▪ Pressure switch shall be installed on the compressed air line. ▪ The supply compressed air shall have 4 Kg / cm^2 pressure and 4 cfm	Acceptable	IQ
Documentation:										
28.	User	Faulty operation & maintenance	Yes	SOPs are basic GMP-requirement	No	NA	High	▪ All end-users have to be trained on SOPs ▪ Training of SOPs has to be documented ▪ Training on the job of end users by vendor. ▪ Training on operation, setting parameters, trouble shooting & maintenance related activities.	Acceptable	OQ/ SOP
29.	User	Operation SOP does not contain proper information and user may operate system	Yes	User may make a wrong decision.	No	NA	High	▪ System operation SOP must be reviewed with all aspects and approved. ▪ Vendor shall provide execution support to the user to complete all stages of the qualification report.	Acceptable	OQ

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30.	Vendor	Technical documentation from vendor not adequate	Yes	Adequate technical documentation is basic GMP requirement	No	NA	High	▪ Vendor documentation (English) shall comprise: -DQ, IQ and OQ -Data sheets -Material certificates -Operating instructions -Maintenance instructions and intervals -Calibration certificates -Parts lists (sufficient detailed: part number, supplier, type) - Drawings P&I-diagrams Electrical diagram - As built GA drawing ▪ Filter certificates ▪ Running trial certificate. ▪ Certificates of bought out components.	Acceptable	IQ

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Acronym	Definition
cGMP	Current Good Manufacturing Practice
db	Decibel
EU-GMP	European –Good Manufacturing Practice
GA	General Arrangement
GMP	Good Manufacturing Practices
IQ	Installation Qualification
MOC	Material Of Construction
OQ	Operational Qualification
O & M	Operation and Maintenance Manual
PQ	Performance Qualification
SOP	Standard Operating Procedures
SS	Stainless steel
URS	User Requirement Specification