

APPENDIX A
DETAILS OF FMEA TEAM MEMBERS

Sr. No.	Name	Affiliation	Expertise Area	Experience
1	Shri Alok Pandey	AERB, Mumbai	Radiation Safety Regulator	13 years
2	Shri Meghraj Singh	AERB, Mumbai	Radiation Safety Regulator	12 years
3	Shri Srikant Vernekar	M/s Radiographic Services India Pvt. Ltd., Mumbai	Radiological Safety Officer	30 years
4	Shri Sai Narayana	M/s IXAR, Mumbai	Radiological Safety Officer	20 years
5	Shri Srirish Raul	M/s Precision Non Destructive Services, Mumbai	Certified Radiographer	35 Years
6	Shri Mahadeo Parab	M/s IIS NDT & Allied Services Pvt. Ltd., Mumbai	Certified Radiographer	28 Years
7	Shri Arvind Panchal	M/s EEC, Mumbai	Maintenance & servicing of IGREDS	15 Years
8	Shri Jayenwant Pawar	M/s EEC, Mumbai	Maintenance & servicing of IGREDS	10 Years
9	Shri Saji Janardan	M/s EEC, Mumbai	Supplier of IGREDS	11 Years
10	Shri P. M. Rahul	M/s Precision NDT, Mumbai	Supplier of IGREDS	10 Years

APPENDIX B

TYPICAL PERFORMANCE CHECKLIST FOR THE IGRED MODEL ROLI-1(SS)

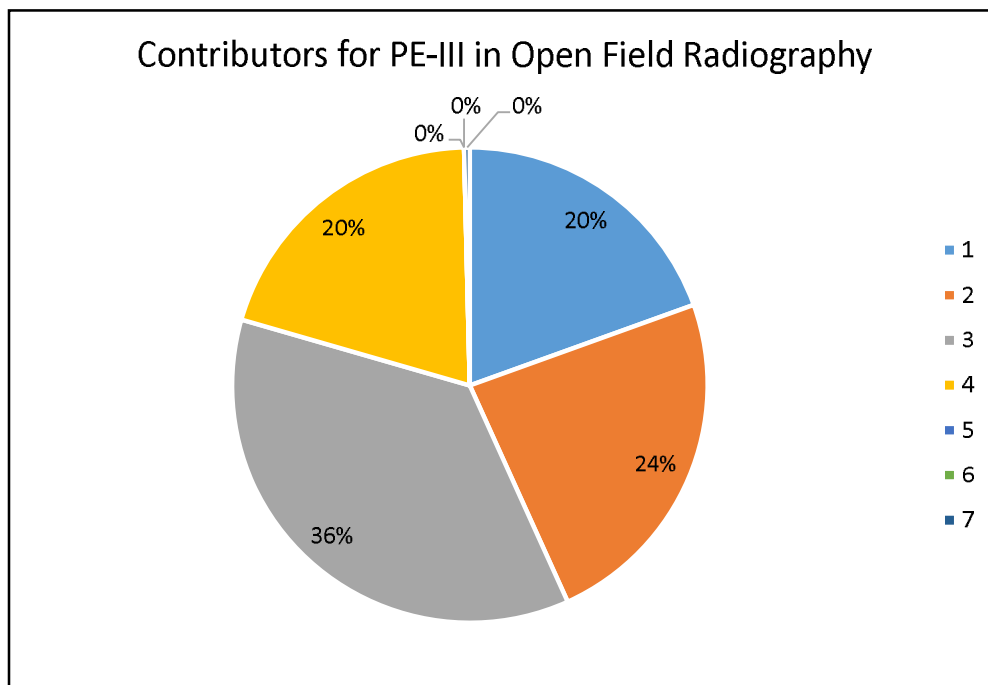
	IGRED Model	ROLI-1 (SS)
1	Sr. No. of the IGRED (as per record)	Present/Not Present
2	Radiation symbol and identification plate	Available/Not available
3 (a)	Physical damage, if any on the IGRED	Yes/No
(b)	Nature of damage (if any)	
4	Lifting handles of the IGRED	Available/Not available
5 (a)	Back cover lock	Working/Not working
(b)	Performance of this lock	Satisfactory/Not satisfactory
(c)	Back cover closing	Proper/Not Proper
6	DRIVING UNIT	
(a)	Drive unit of the IGRED	Available/Not available
(b)	Sr. No. of IGRED on the drive unit	Engraved/Not engraved
(c)	Operation of the drive unit	Satisfactory/Not satisfactory
(d)	Odometer on the drive unit	Available/Not available
(e)	Functioning of the odometer	Proper/Not proper
7	DRIVE CABLE/CONTROL CABLE	
(a)	Crimping of male coupler with drive cable	Proper/Not proper
(b)	Physical damage, if any, on male coupler	Yes/No
(C)	If Yes, nature of damage	
(d)	Flexibility of the drive cable new male coupler	Proper/Not proper
(e)	Dimensions of male coupler: Ball Dia.(4mm)	Proper/Not proper
(f)	Neck diameter (2.4mm)	Proper/Not proper
(g)	Length of Ball+Neck(16mm)	Proper/Not proper
(h)	Straightness of the male coupler	Proper/Not proper
8	SOURCE HOLDER ASSEMBLY/SOURCE PIGTAIL	
(a)	Length of the source holder assembly (171mm)	Proper/Not proper
(b)	Overall diameter of the female coupler	Proper/Not proper
(c)	Overall length of the female coupler	Proper/Not proper
(d)	Diameter of the ball in the source holder assembly (7.5mm)	Proper/Not Proper
(e)	Length of the canal	Proper/Not proper
(f)	Width of the canal	Proper/Not proper

(g)	Diameter of the socket(Please check with Jig and GO-NO-GO Gauge)	Proper/Not proper
(h)	Distance between ball and female coupler(43mm)	Proper/Not proper
(i)	Straightness of female coupling end	Proper/Not proper
(j)	Physical damage, if any in the female coupler	Yes/No
(k)	If Yes, nature of the damage	
9	Is coupling between male and female coupler possible with an angle less than 45°	Yes/No
10	Whether-source assembly can be removed from the rear lock	Yes/No
11 (a)	Functioning of the rear body lock	Proper/Not proper
(b)	In unlocked condition of the body lock, whether the source holder release knob can be pressed fully	Yes/No
12	Functioning of the split coupling	Proper/Not proper
13	Functioning of the sliding ring	Proper/Not proper
14	Whether without coupling male and female coupler, is it possible to close the sliding ring	Yes/No
15	If yes, whether it is possible to project the source assembly forward in unlocked condition	Yes/No
16 (a)	Guide tubes 1m and 3m	Available/Not available
(b)	Source stopper plug	Available/Not available
(c)	Source stopper plug	Proper/Not proper
17 (a)	Source holder arrestor assembly on the front side	Available/Not available
(b)	Functioning of the source arrestor pin at the front side	Proper/Not proper
(c)	Threading of the guide tube coupler	Proper/Not proper
(d)	Is there any play between guide tube and IGRED	Yes/No
(e)	Threading of the front cap	Proper/Not proper
17	Couple the guide tube with the IGRED properly. Couple the drive cable with the source holder assembly properly. Unlock the body lock, press the source holder release knob and drive the pigtail out. Movement of the source holder in the 1m and 3m guide tubes	Proper/Not proper

18	Retract the pigtail back to the IGRED. Check the movement of the source holder through the guide tube multiple times. Movement of the source holder	Proper/Not proper
19	Whether the source holder release knob pops up automatically when the when the source comes back to its safe position in the device	Yes/No
20	After every operation, whether the source holder assembly has been fully retracted back to the IGRED	Yes/No
21	Without coupling the male and female coupler, Is it possible to close the sliding ring?	Yes/No
	Reasons for Rejection: 1. 2. 3. 4.	
	IGRED Approved/Rejected: Checked by: Signature: Name: Date: Designation	

APPENDIX C

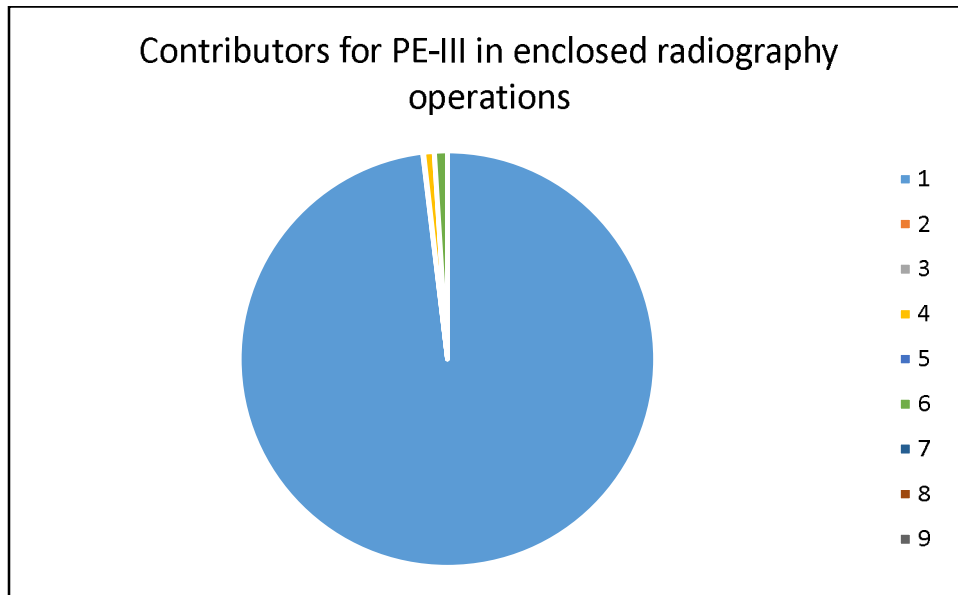
MAIN CONTRIBUTORS FOR PE-III CATEGORY OF EXPOSURES IN OPEN FIELD AND ENCLOSED RADIOGRAPHY



Legend	1	2	3	4	5	6	7
Percentage contribution	19.53	23.72	36.20	20.19	<0.01	<0.01	0.37

Legends for the above chart is the below sequence followed by source stuck in the projection sheath.

1. Guide tube not surveyed after source is retracted into the device.
2. Not carrying the radiation survey meter when going to retract the source after operation.
3. Radiography device is being operated by an untrained person.
4. Radiation Survey meter is not carried to the field for radiography operations.
- 5, 6 & 7 are due to not combined failure of carrying radiation survey meter to the field and device operated by untrained person.



Legend	1	2	3	4	5	6	7	8	9	10
Percentage contribution	98.06	0.07	0.05	0.75	0.06	1.0	0.01	<0.01	<0.01	<0.01

Legend 1 in above chart is the failure sequence of the device operated by untrained person followed by source stuck in the guide tube.

It is evident from the above charts that only four failure sequence contributes to more than 99 percentage of potential exposure (PE-III) in case of open field radiography; and one failure sequence contributes to about 98 percentage of potential exposure (PE-III) in enclosed radiography. These failure sequences have been addressed and recommendations have been made in Section 6.6 of Chapter 6 of this thesis, to reduce the specific failure which contributes significantly in each scenario.