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Safety and Reliability of Embedded Systems

**Problem Set 4 (Problem1)** 



You work in the quality assurance department of a motorbike manufacturer company and your manager asks you to do a "Failure Modes, Effects, and Criticality Analysis" (FMECA) for the newest product:



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#### **Problem 1: Motorbike - specifications**

#### The headlight and backlight are both composed of the following parts:

- Housing
- Bulb
- Socket (for bulb)
- Reflector
- Soldering joints (to connect cabling to socket)
- Frame mount

The **cabling** consists of these parts:

- Isolation
- Wire
- Cable mount

The **battery** is treated as an encapsulated component and is not decomposed any further.



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#### **Problem 1: Motorbike - specifications**

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- From your experience in the field of electrical lighting systems for motorbikes, you know that you have to **consider the following aspects during the analysis:**
- Humidity, corrosion
- Mechanical damage, cracks
- Loose-fitting parts, screws not tightened
- Wrong/defective bulbs
- Broken wires, short circuit
- High contact resistance, no electrical contact
- Bad/broken soldering joints
- Uncharged/half-charged/broken batteries
- No/pale light, impaired light beam



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Please do a **FMECA** for the headlight/backlight of the motorbike by using the given template.

Assign **rankings** for severity of consequences (S), occurrence probability (O), and probability of non-detection (D), and calculate the associated risk priority numbers (RPN).

On which **failure modes** would you focus your attention? What are your **suggestions** for corrective measures?

- **Note:** S: severity of consequences (1 ... 10)
  - O: occurrence probability (1 ... 10)
  - D: probability of non-detection (1 ... 10)
  - RPN: risk priority number (1 ... 1000)



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## Solution - FMECA (1)



Ref. no.	Component	Failure mode	Effect of failure	Failure cause	S	0	D	RPN	Corrective measures
1	Bulb	Light works intermittently	No light	Defective bulb	8	4	2	64	Test bulb before assembly
2				Loose-fitting bulb within socket	8	6	7	336	Check fitting of bulb during assembly
3				Broken wire	8	3	8	192	Measure wire resistance before assembly
4				Short circuit	8	5	7	280	Use cable bushing to prevent damage to isolation of cable
5				Uncharged battery	8	ფ	2	48	Check charge state before delivery to customer
6				Broken battery	8	2	2	32	Change external supplier
7				Broken soldering joint(s)	8	4	8	256	Use cable bushing to reduce mechanical stress

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## **Solution - FMECA (2)**



Ref. no.	Component	Failure mode	Effect of failure	Failure cause	S	0	D	RPN	Corrective measures
8		Light works intermittently	Pale light	Half-charged battery	6	3	2	36	Check charge state before delivery to customer
9				Bad soldering joint(s)	6	6	8	288	Improve soldering procedure and material
10				Wrong bulb type	6	5	2	60	Check bulb type before assembly
11	Reflector	Reflector does not reflect light properly	Pale light	Corroded reflector	6	5	10	300	Improve housing gasket; check tightness
12			Impaired light beam	Cracked reflector	4	3	5	60	Change external supplier
13	Housing	Untight housing	Humidity enters case	Components of case do not fit	2	2	2	8	Change external supplier
14		Damaged housing		Improper assembly	2	7	7	98	Improve assembly procedure

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Ref. no.	Component	Failure mode	Effect of failure	Failure cause	S	0	D	RPN	Corrective measures
15	Socket	No electrical contact to bulb	No light	Broken socket	8	3	2	48	Change external supplier
16		Contact resistance too high	Pale light	Corrosion within socket	6	5	10	300	Improve housing gasket
17	Frame mount	Loose-fitting frame mount	Headlight/ backlight could fall off	Screws not tightened	10	6	7	420	Improve assembly procedure



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#### **Solution – Fault Tree 1**





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