ELSA-2-5

Proposal for Rulemaking Process of Electrical Safety Regulation for Fuel Cell Vehicle High Voltage Systems

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May 2008

Contents

Introduction

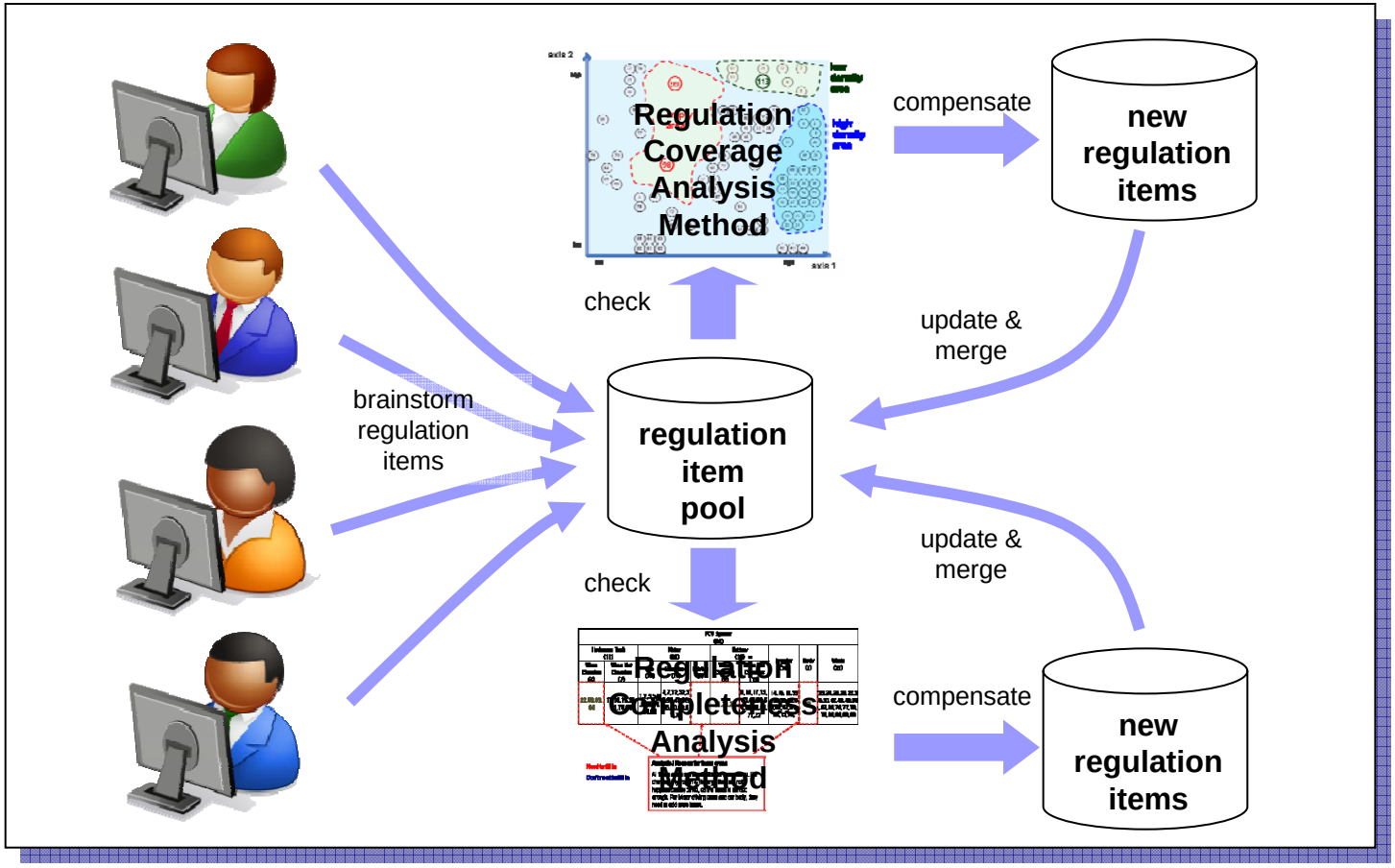
- Background
  - Regulations are needed for ensuring safe operation of FCV high voltage system
    - To prevent fire, explosion, human injuries
  - Complex system behavior makes it difficult to generate regulation which can prevent all possible accidents
    - A methodology to check the coverage and completeness of the regulation items is needed

- Objective
  - Propose a rulemaking process of electrical safety regulation for fuel cell vehicle high voltage systems
    - Capable of checking coverage, completeness
    - Capable of suggesting new regulations from existing regulations

Contents

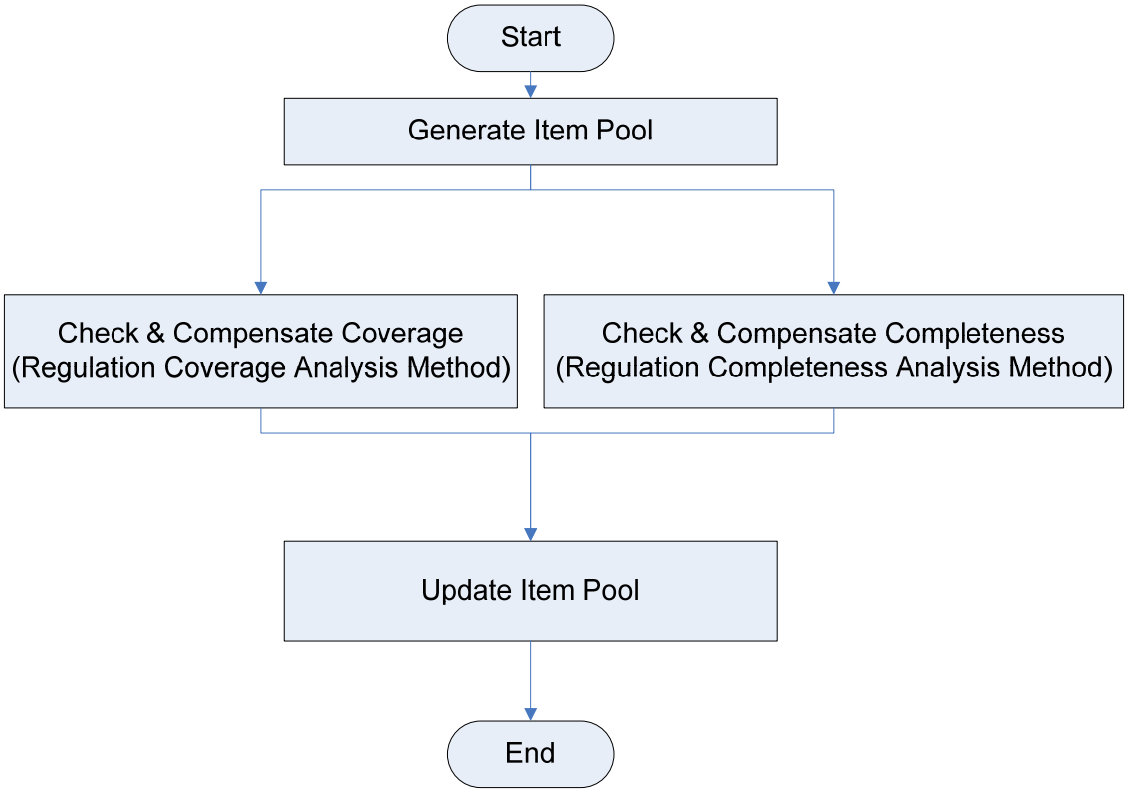
Process Introduction

- Concept
  - Generate requirement list by brain storming and update the requirements systematically
    - Use Regulation Coverage Analysis Method to check and improve coverage of regulated areas
    - Use Regulation Completeness Analysis Method to check and improve completeness of requirements



Process Introduction

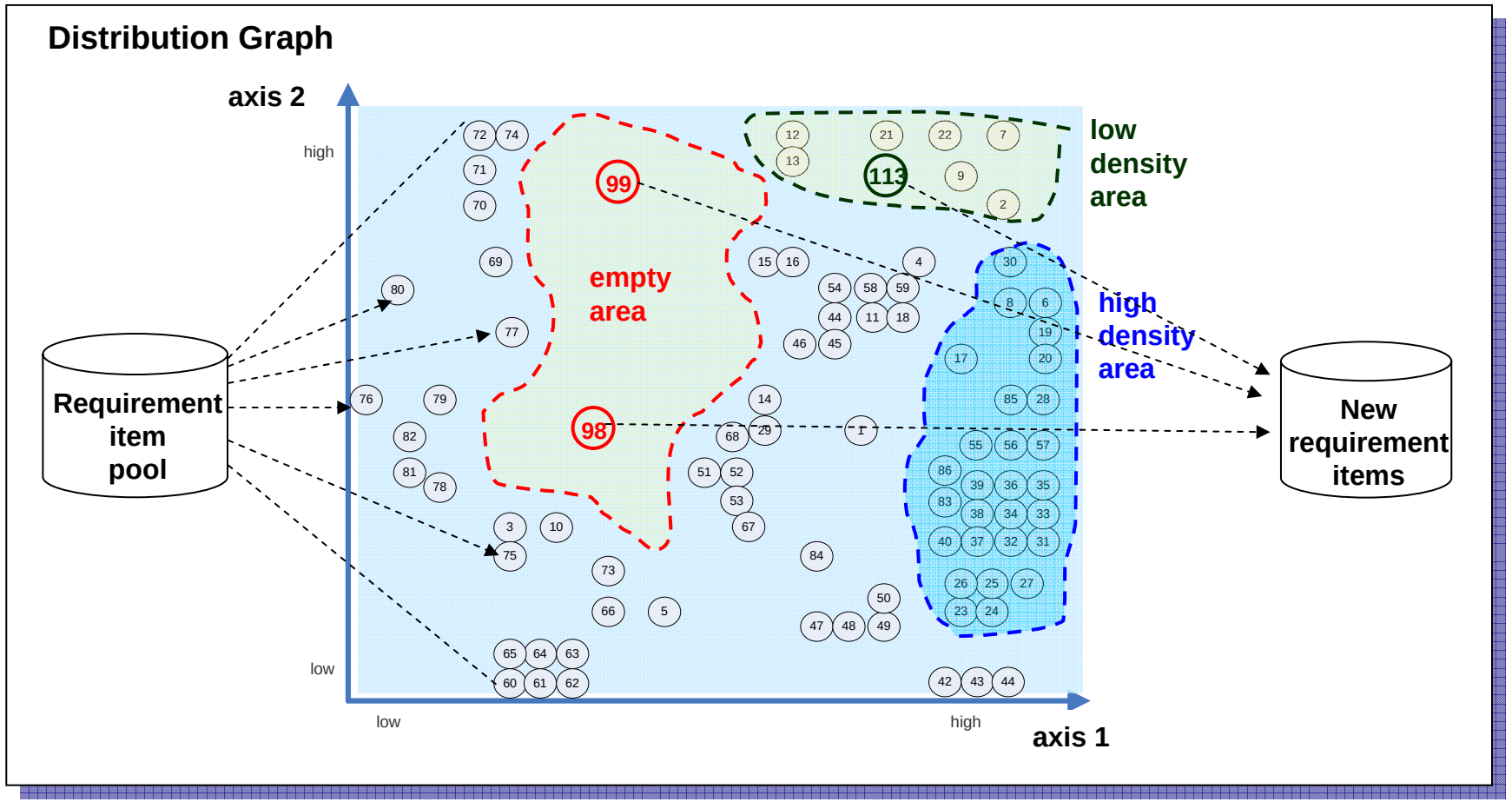
- Flow chart
  - Generate new requirement item pool
    - Make an item pool that stores requirement items
    - Generate requirement items by brainstorming
  - Check & compensate coverage
    - Use proposed “Regulation Coverage Analysis Method”
  - Check & compensate completeness
    - Use proposed “Regulation Completeness Analysis Method”
  - Update requirement item pool
    - Update item pool by adding new requirement items



Contents

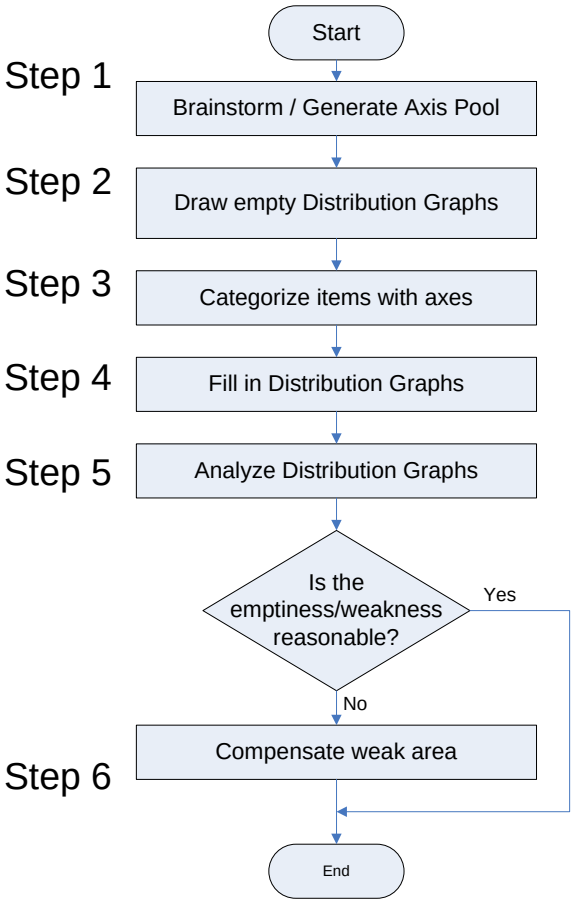
Regulation Coverage Analysis Method

- Concept
  - Distribute requirement items onto “Distribution Graph” to check coverage and compensate low density areas



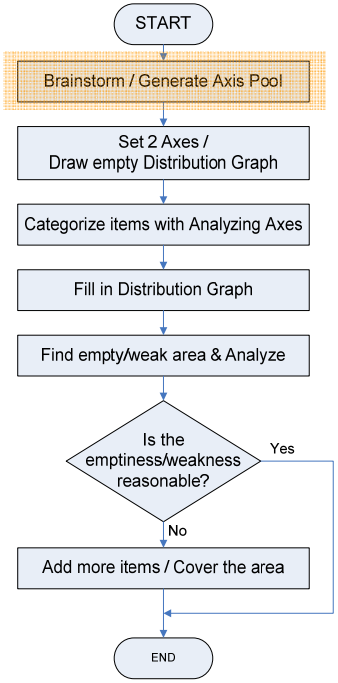
Regulation Coverage Analysis Method (Cont'd)

- Flowchart

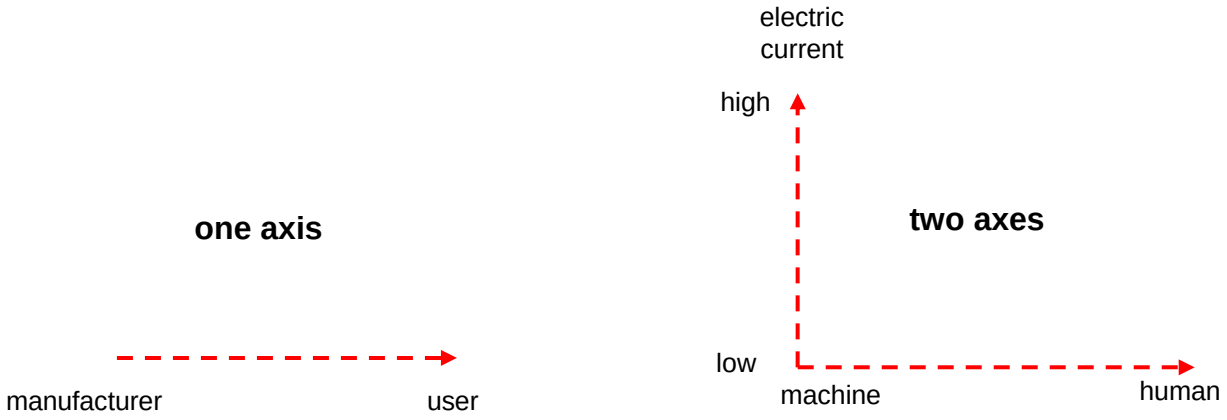


- Step 1: Brainstorm / Generate axis Pool
- Step 2: Draw empty Distribution Graphs
- Step 3: Categorize items with axes
- Step 4: Fill in Distribution Graphs
- Step 5: Analyze Distribution Graphs
- Step 6: Compensate weak area

Step 1: Brainstorm / Generate Axis Pool

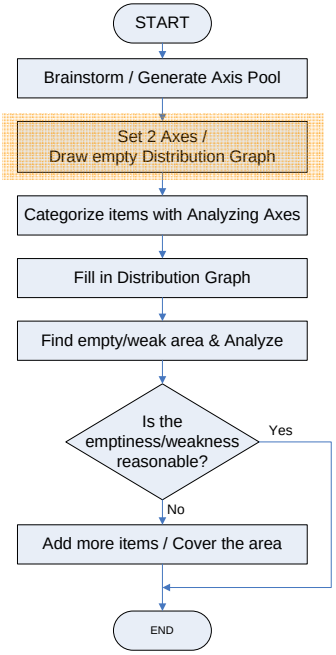


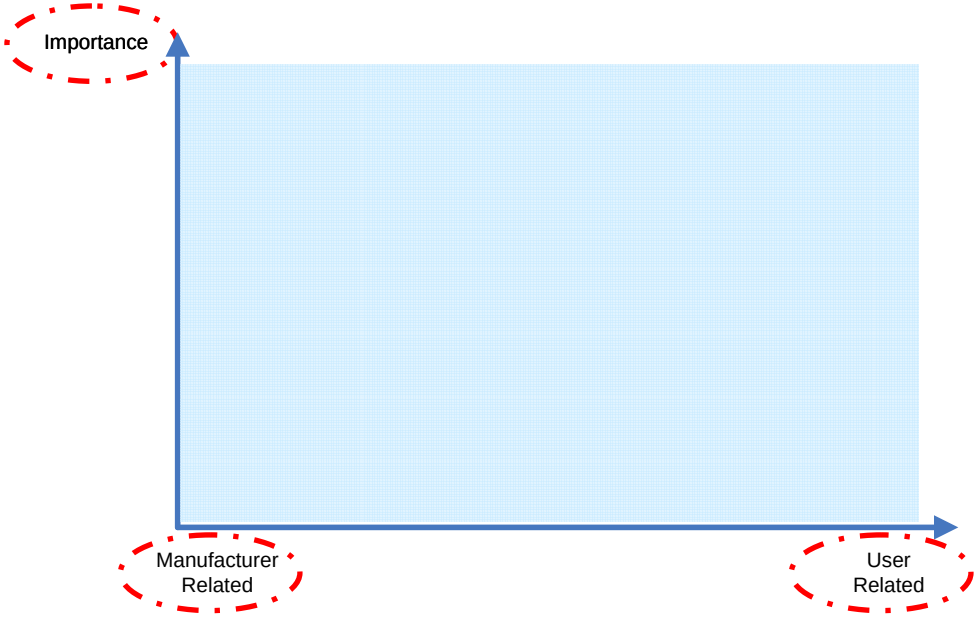
- Brainstorm as many axes as possible which can be used to check the coverage of requirement items
  - Add axes into axis pool
  - Examples of axes
    - Probability of successive accident
    - Manufacturer-related to user-related
    - Machine-related to human-related
    - Low electric current to high electric current
    - Idle speed to high speed



Step 2: Draw empty Distribution Graphs

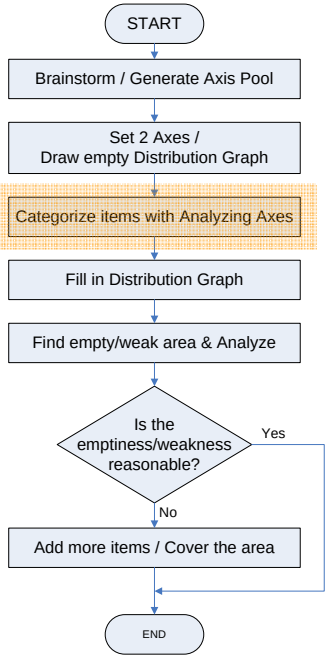
- Select two axes and draw Distribution Graphs
  - Consider all possible combinations formed by two axes out of axis pool
  - Select two axes whose combination is meaningful
  - Example
    - Axis 1: manufacturer-related to user-related
    - Axis 2: low probability to high probability of accident





Step 3: Categorize items with axes

- Assign numbers to every requirement item of the item pool for every axis
  - Requirement items are categorized by the assigned numbers
  - Example (with Microsoft Excel)
    - User orientation: from 1(manufacturer-related) to 10(user-related)
    - Probability of successive accident: from 1(low) to 10(high)



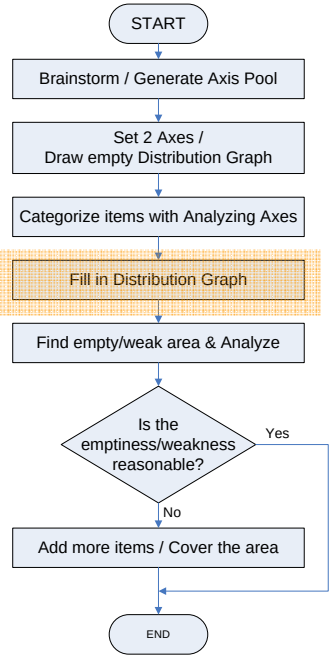
probability of accident

manufacturer ↔ user

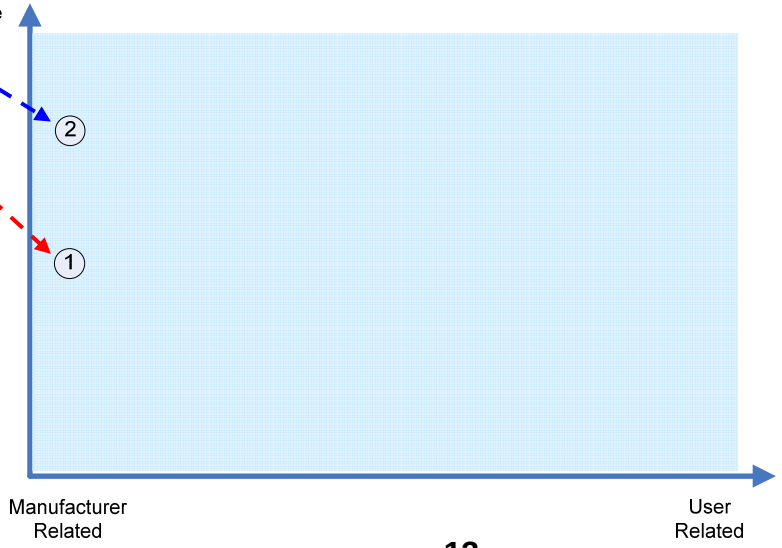
No	Items	Importance	Manufacturer <-> User	Idle <-> Energized	Normal <-> Accidental	Tested <-> Just follow
1	Motor must be separated by at least XX cm from the vehicle chassis.	5	1	2	1	1
2	Motor must be separated by at least XX cm from hydrogen tank and fuel cell stack.	8	1	2	1	1
3	Motor must be separated by at least XX cm from inverter and battery.	4	1	2	1	1
4	Motor must be electrically isolated from the chassis ground, the electrical isolation between motor and ground must be greater than XX Ohm.	7	1	2	1	1
5	Motor coil must be insulated from outside to prevent arcing.	2	2	2	1	2
6	Motor must be shielded by metallic enclosure which is grounded to chassis ground and shielding enclosure of motor must be insulated from outside.	7	2	2	1	2
7	When an accident occurs, connection between motor and inverter must be blocked so that the motor should be de-energized to prevent following accidents.	10	5	2	2	2
8	Propulsion battery must be separated by at least XX cm from hydrogen tank and fuel cell stack.	7	1	2	1	1
9	Propulsion battery must be electrically isolated from the chassis ground, the electrical isolation between battery and ground must be greater than XX kOhm.	9	2	2	1	1
10	Propulsion battery must be insulated from the other electric components.	3	1	2	1	2
11	Battery must be shielded by metallic enclosure which is grounded to chassis ground and shielding enclosure of battery must be insulated from outside.	7	2	2	1	2
12	When an accident occurs, power connection between battery and inverter must be blocked so that the vehicle should be de-energized.	10	4	3	2	2
13	Even when an accident occurs, battery must be isolated from physical contact with passengers.	9	5	2	2	2

Step 4: Fill in Distribution Graphs

- Place requirement items into Distribution Graphs
  - For each requirement item, check numbers of two axes in the item pool
  - Place requirement on item into area decided by the numbers of two axes of the Distribution Graph

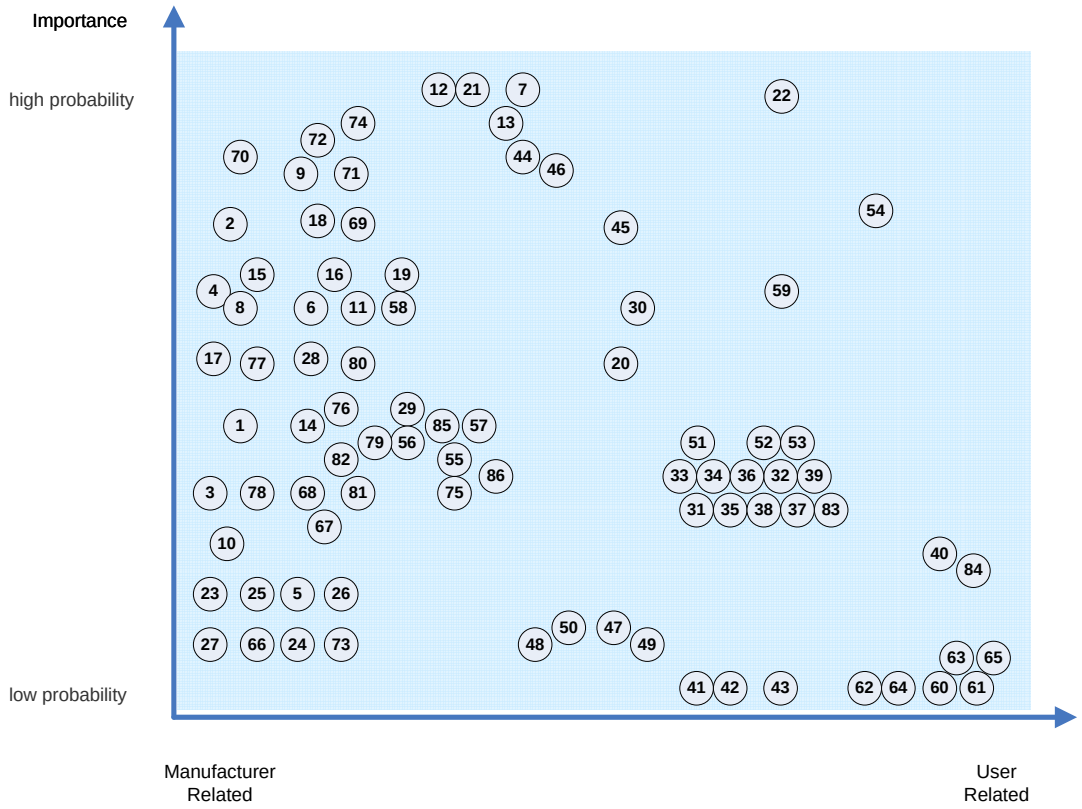


No	Items	Importance	Manufacturer <-> User	Idle <-> Energized	Normal <-> Accidental	Tested <-> Just follow
1	Motor must be separated by at least XX cm from the vehicle chassis.	5	1	2	1	1
2	Motor must be separated by at least XX cm from hydrogen tank and fuel cell stack.	8	1	2	1	1
3	Motor must be separated by at least XX cm from inverter and battery.	4	1	2	1	1
4	Motor must be electrically isolated from the chassis ground, the electrical isolation between motor and ground must be greater than XX Ohm.	7	1	2	1	1
5	Motor coil must be insulated from outside to prevent arcing.	2	2	2	1	2
6	Motor must be shielded by metallic enclosure which is grounded to chassis ground and shielding enclosure of motor must be insulated from outside.	7	2	2	1	2



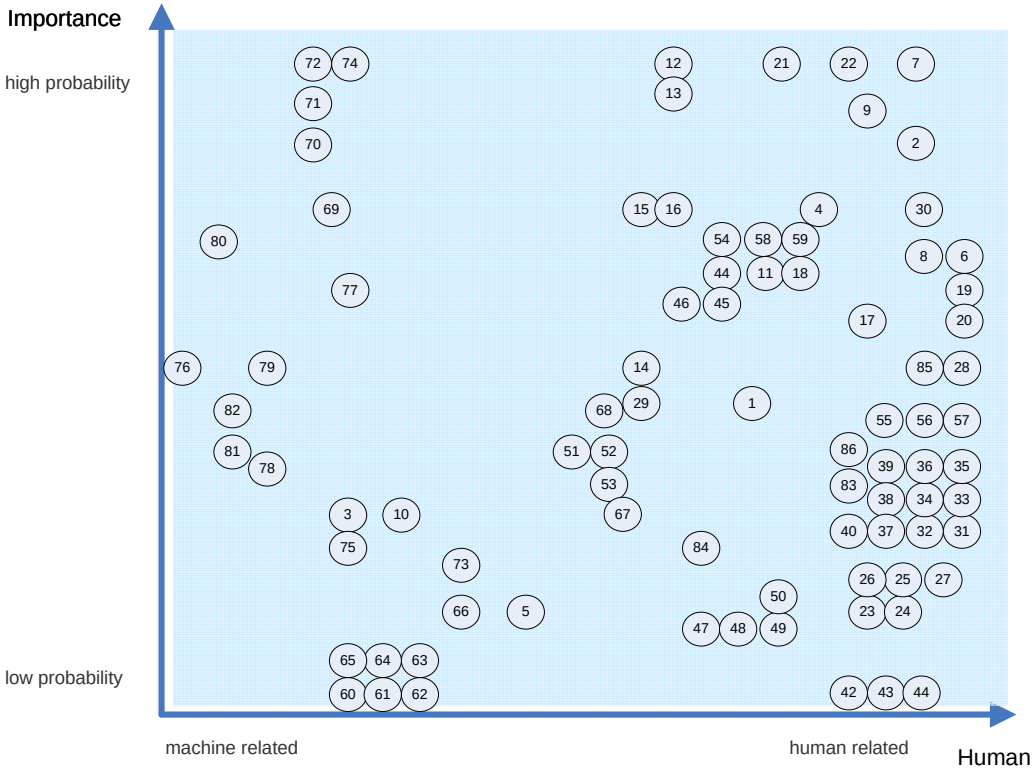
Step 4: Fill in Distribution Graphs (Cont'd)

- Example of Distribution Graph #1
  - Axis 1: manufacturer-related to user-related
  - Axis 2: low probability to high probability of accident



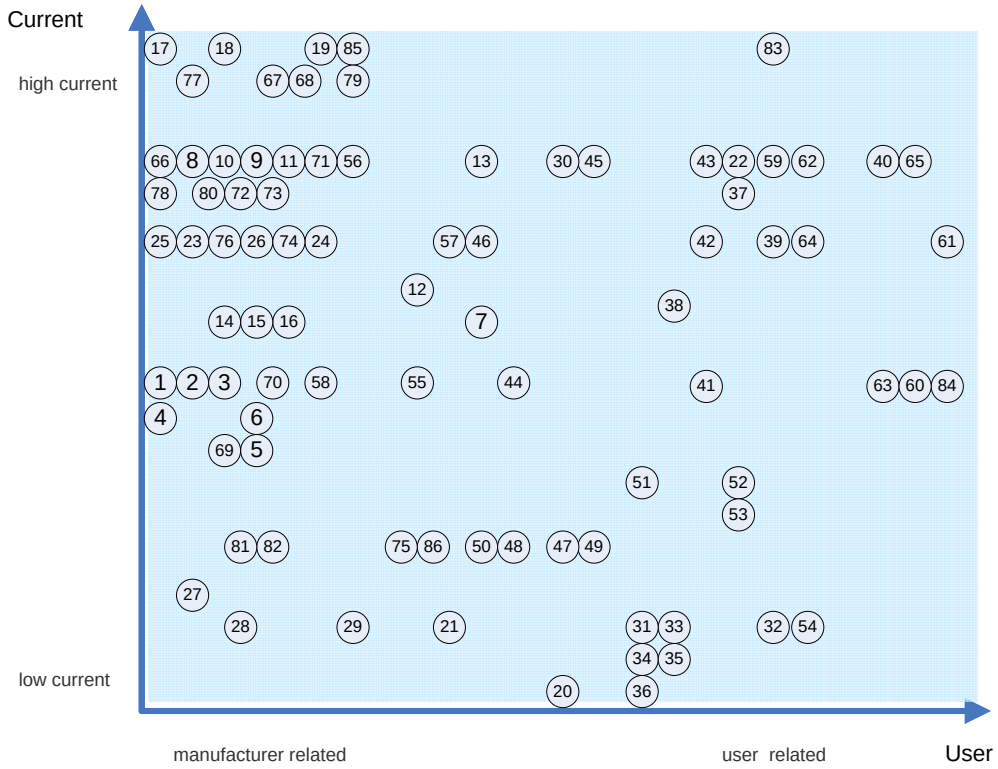
Step 4: Fill in Distribution Graphs (Cont'd)

- Example of Distribution Graph #2
  - Axis 1: machine-related to human-related
  - Axis 2: low probability to high probability of accident



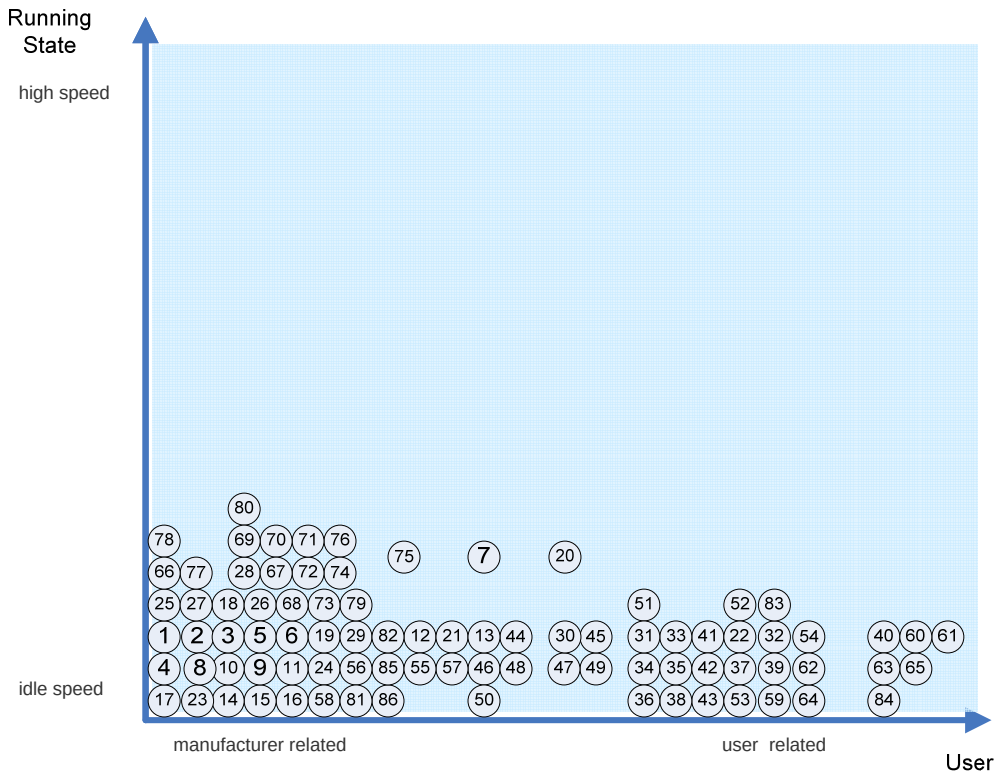
Step 4: Fill in Distribution Graphs (Cont'd)

- Example of Distribution Graph #3
  - Axis 1: manufacturer-related to user-related
  - Axis 2: low electric current to high electric current



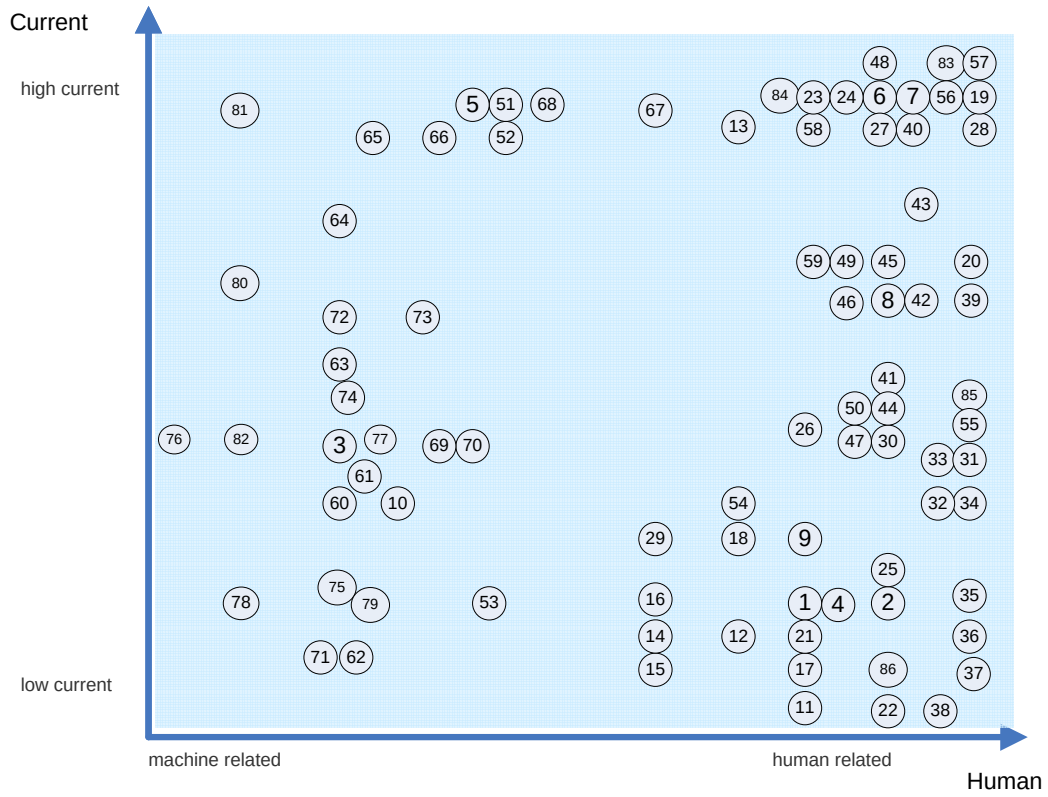
Step 4: Fill in Distribution Graphs (Cont'd)

- Example of Distribution Graph #4
  - Axis 1: manufacturer-related to user-related
  - Axis 2: idle speed to high speed



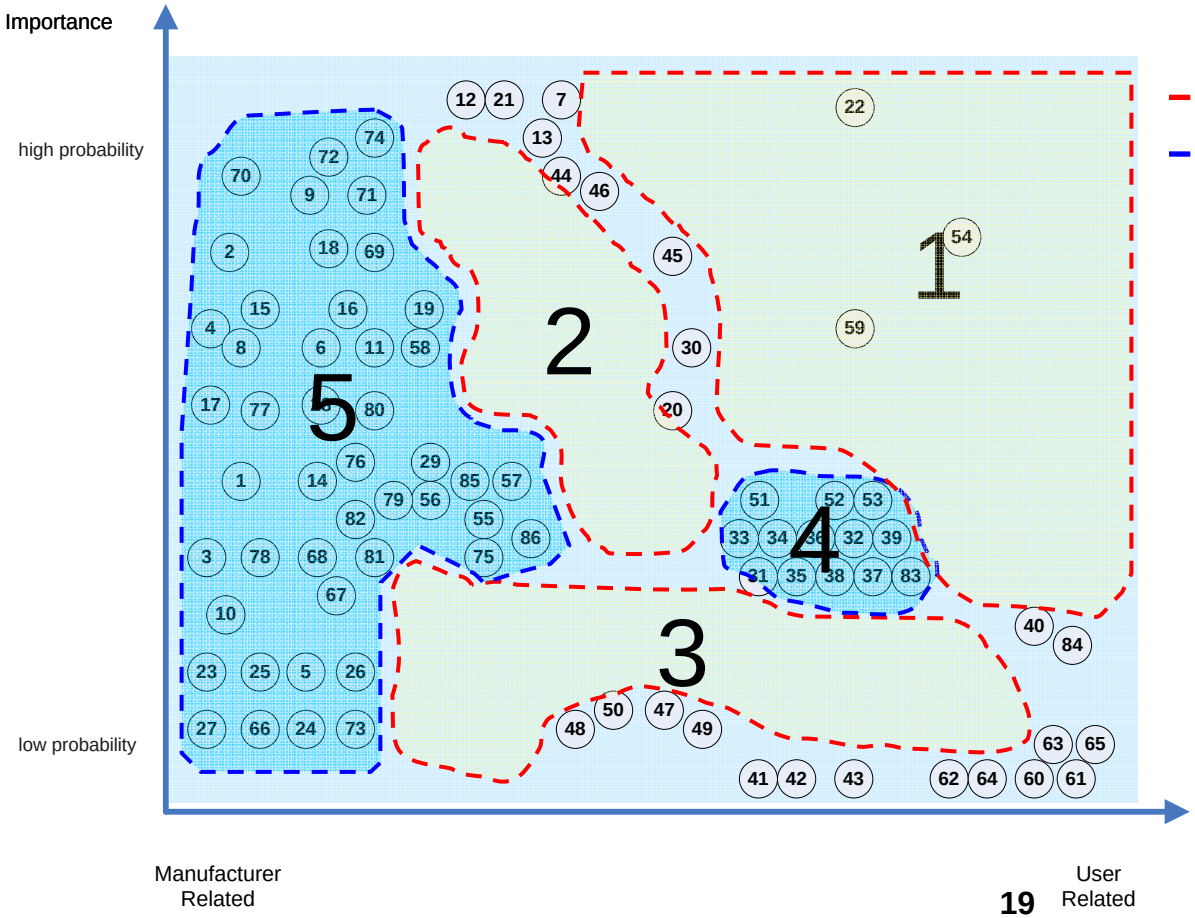
Step 4: Fill in Distribution Graphs (Cont'd)

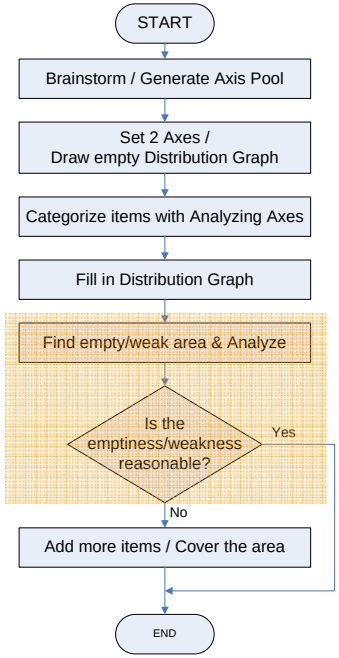
- Example of Distribution Graph #5
  - Axis 1: machine-related to human-related
  - Axis 2: low electric current to high electric current



Step 5: Analyze Distribution Graphs

- Mark low density areas and high density areas to analyze distribution of the regulation items
- Assign zone to each area
  - Analyze implications using two axes information for each zone





Zone 1: High probability of accident caused by user responsibility

Zone 2: High and medium probability of accident caused by both user and manufacturer responsibility

Zone 3: Low probability of accident caused by both user and manufacturer responsibility

Zone 4: Medium probability of accident caused by user responsibility

Zone 5: Manufacturer oriented responsibility

Step 5: Analyze Distribution Graphs (Cont'd)

- Analyze low density zones
  - Decide whether more requirement items are needed
    - If the low density zones are reasonable, more items are not required
  - Also, check whether the low density is a result of inappropriate axis selection

Description:

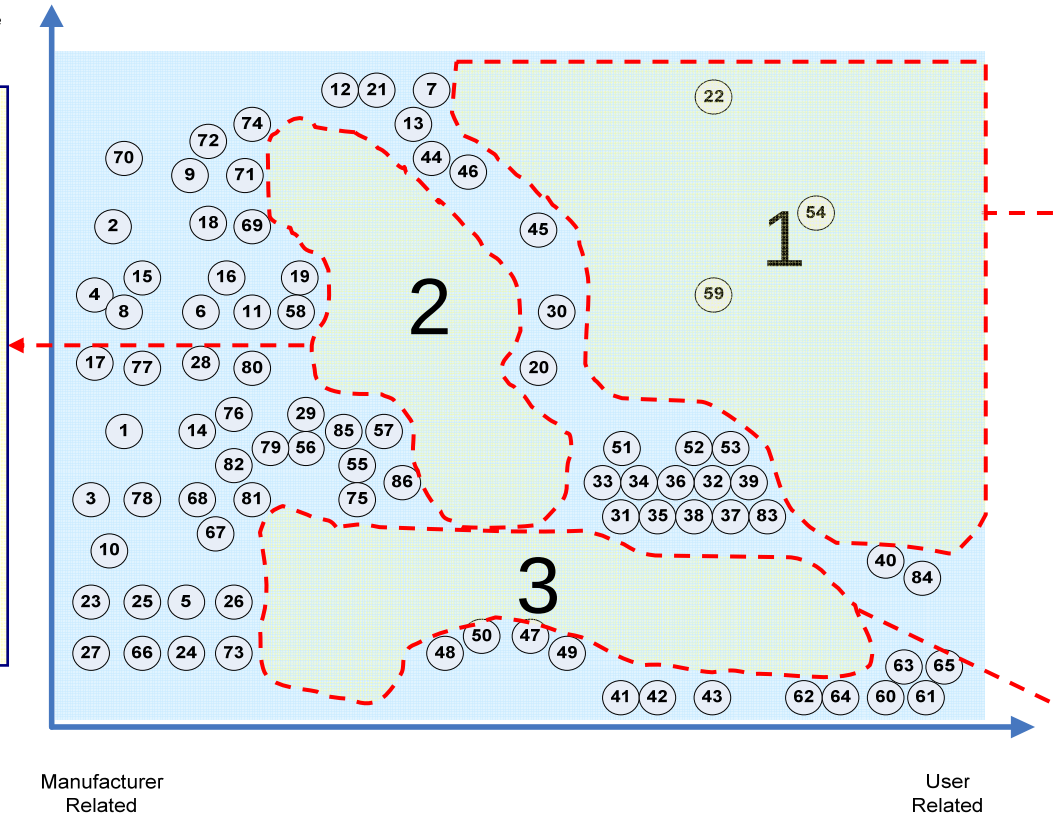
High and medium probability of accident caused due to both user and manufacturer responsibility

Distribution Density:
Very low

Analysis:
No specific reason for emptiness

Conclusion:

Need to be filled



Description:
High probability of accident caused due to user responsibility

Distribution Density:
Very low

Analysis:
Users don't need to take high responsibility

Conclusion:
No need for more regulations

Description:
Low probability of accident caused due to both user and manufacturer responsibility

Distribution Density:
Very low

Analysis:
No specific reason for emptiness. Typical safety related working environment can be added

Conclusion:
Need to be filled

Step 5: Analyze Distribution Graphs (Cont'd)

- Analysis of high density zones
  - Decide whether to merge certain regulation items or not
    - If there are duplicated items, merge them
  - Also, check whether the high density is a result of inappropriate axis selection

Description:

Manufacturer oriented responsibility

Distribution Density:

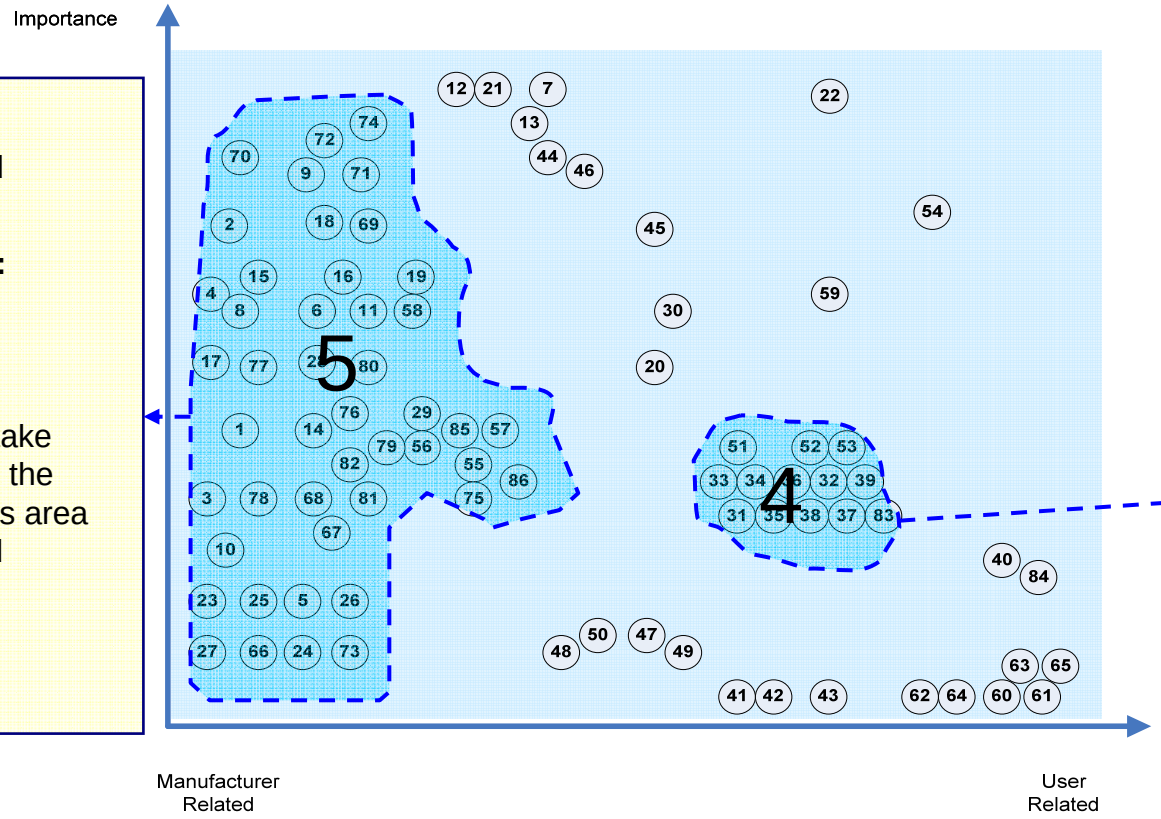
High

Analysis:

Manufacturer should take main responsibility for the safety of FCV, and this area shows well-distributed regulation items.

Conclusion:

Well covered



Description:

Medium probability of accident caused by user responsibility

Distribution Density:

Very high

Analysis:

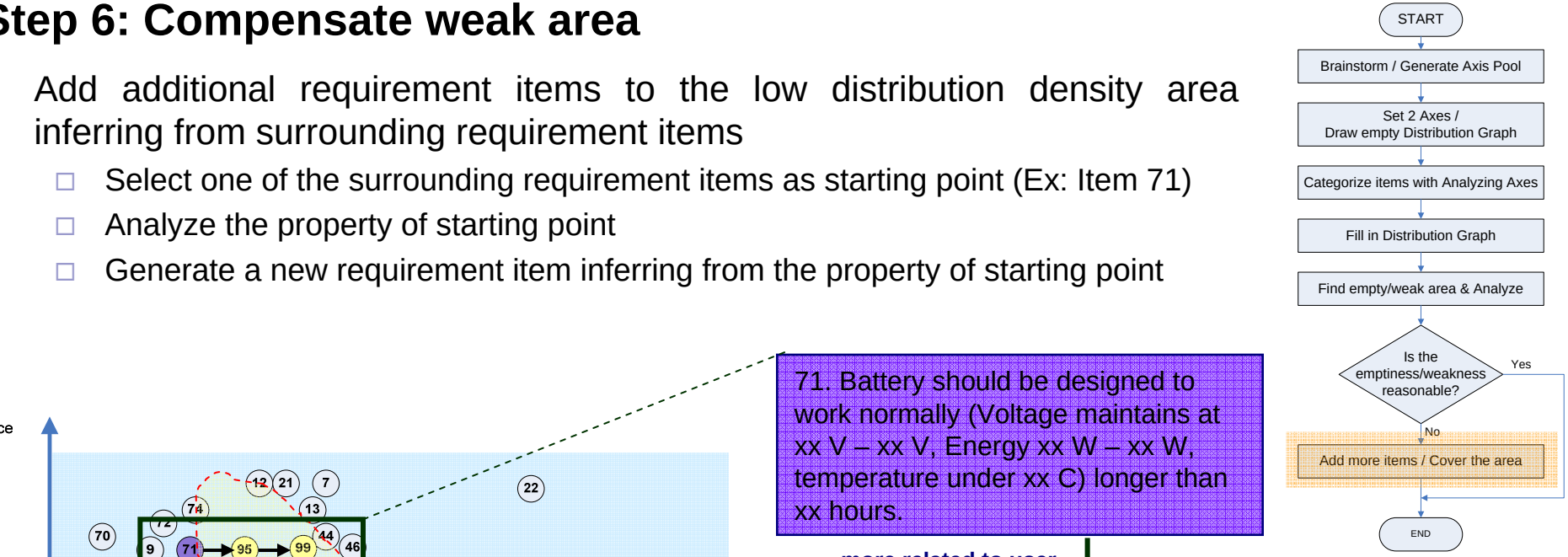
High density caused by diagnosis and auto repair shop activities

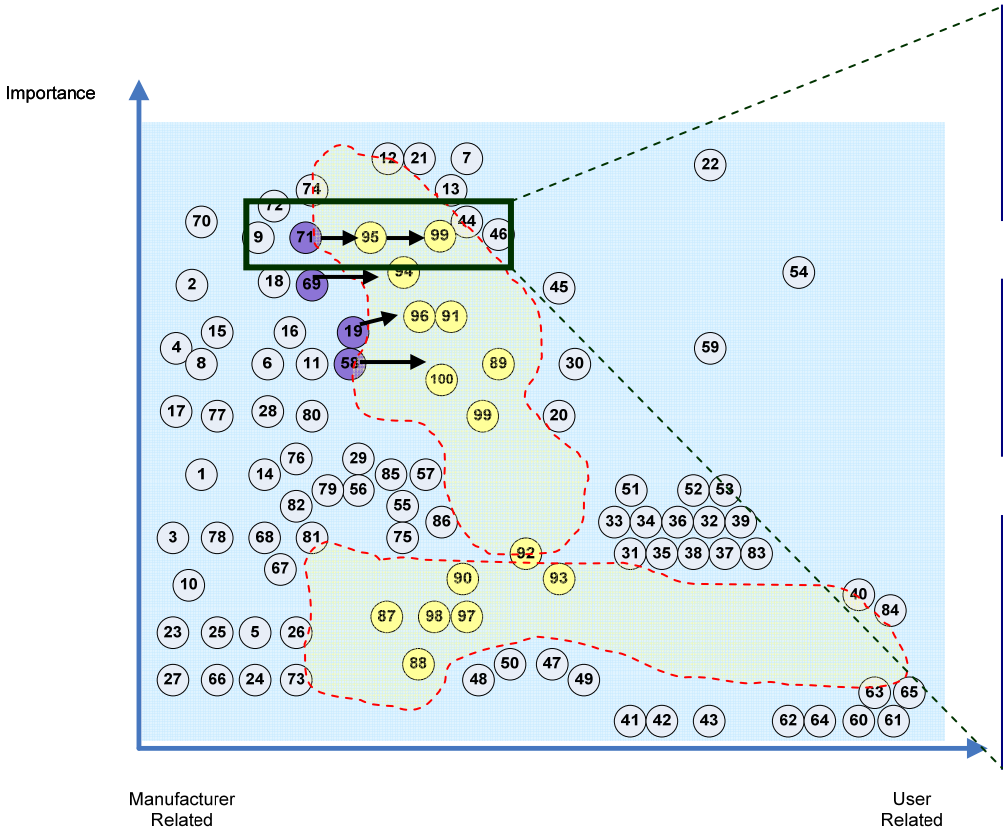
Conclusion:

Well covered

Step 6: Compensate weak area

- Add additional requirement items to the low distribution density area inferring from surrounding requirement items
  - Select one of the surrounding requirement items as starting point (Ex: Item 71)
  - Analyze the property of starting point
  - Generate a new requirement item inferring from the property of starting point





71. Battery should be designed to work normally (Voltage maintains at xx V – xx V, Energy xx W – xx W, temperature under xx C) longer than xx hours.

more related to user

95. Every battery should be diagnosed before released to market. Battery should work normally as specified in regulation item 71.

more related to user

99. A 10 Year warranty should be given by manufacturer to the customer. Incase if the normal work condition of item 71 is not satisfied, battery should be replaced free of charge.

Result of Regulation Coverage Analysis Method

- 86 items before process applied
- 21 items can be added after Regulation Coverage Analysis Method

Items after process applied

Items before process applied

Nl	Items
74	Inverter should be working normally (temperature under XX °C) in XX frequency longer than XX hours.
75	Communication cable of Hydrogen tank should be shielded.
76	2 cables with XXV voltage input/output should be placed apart more than XX cm.
77	Power cable noise frequency should be in the range of XX KHz to XX MHz.
78	Antenna frequency should be in the range of XX KHz to XX MHz.
79	Shield effectiveness between each electric device should be more than XX dB.
80	No unwanted propagation of interference energy.
81	All wires should be shielded.
82	All shields of cables should be grounded.
83	Use tools with insulated handles at the end when charging the Hydrogen (Insulation shoes should meet the electrical regulation XXX)
84	When finish charging Hydrogen, we should wait at least XX minutes until the motor is turned on.
85	Indicator for voltage level generated in fuel cell stack must be mounted to the vehicle
86	Any cable which carries high voltage / large current should not pass near interior of vehicle, it should be seperated from the interior at least by XX cm
87	
88	
89	
90	
91	
92	
93	
94	
95	
96	

104	When soldering red color cable the soldering point should not change the insulation thickness by XX mm. If the thickness changed by more than XX mm, Note should be taken in this issue.
105	When debugging with motor an additional button which could cut off all the electricity at one press should be available. This button should be given with bright color (Ex: red)
106	When debugging with battery an additional button which could cut off all the electricity at one press should be available. This button should be given with bright color (Ex: red)
107	When debugging with inverter an additional button which could cut off all the electricity at one press should be available. This button should be given with bright color (Ex: red)
108	All connections to inverter with voltage in range (xxV-yyv) should be insulated with (zz materials) with tt thickness
109	All connections from inverter with voltage in range (xxV-yyv) should be insulated with (zz materials) with tt thickness
110	All connections to battery with voltage in range (xxV-yyv) should be insulated with (zz materials) with tt thickness
111	All connections from battery with voltage in range (xxV-yyv) should be insulated with (zz materials) with tt thickness
112	All connections to motor with voltage in range (xxV-yyv) should be insulated with (zz materials) with tt thickness
113	All connections from motor with voltage in range (xxV-yyv) should be insulated with (zz materials) with tt thickness
114	Hydrogen tank's metal case should be painted with insulation paint materials with xx color
115	Motor's metal case should be painted with insulation paint materials with xx color
116	Inverter's metal case should be painted with insulation paint materials with xx color
117	Battery's metal case should be painted with insulation paint materials with xx color

Added Item Poll

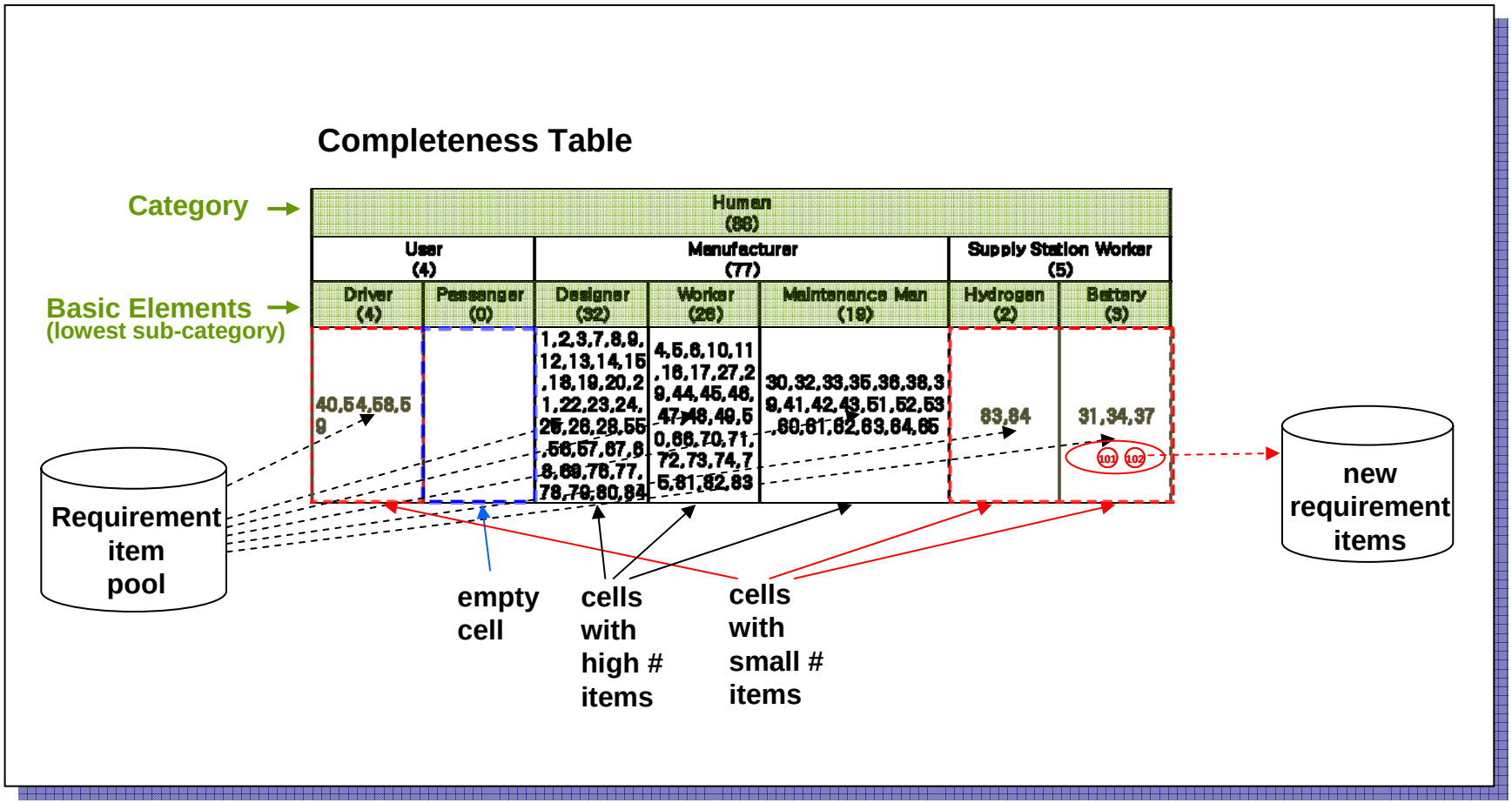
item pool before process applied

item pool after process applied

Contents

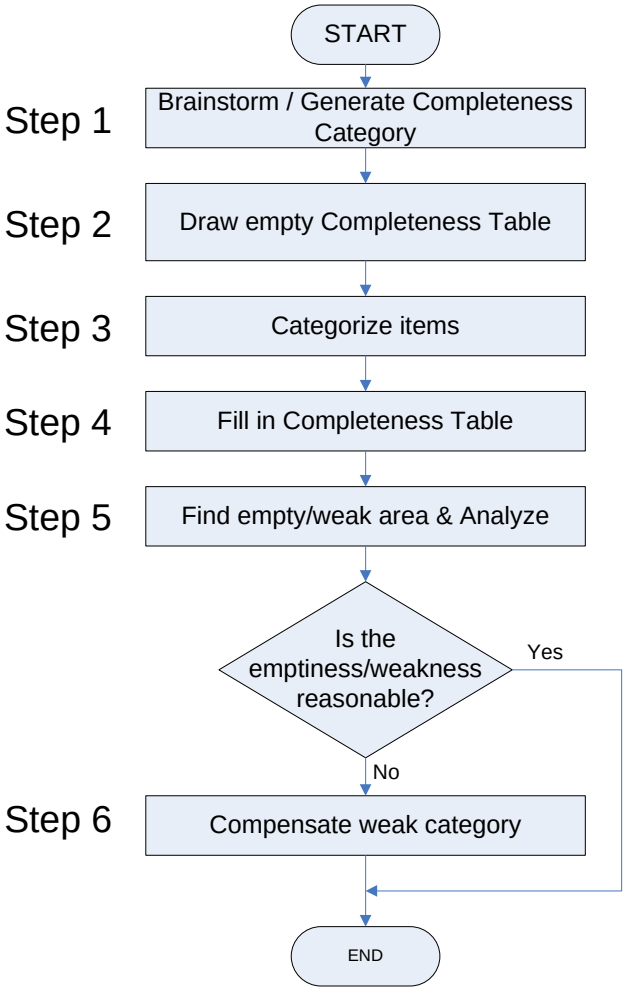
Regulation Completeness Analysis Method

- Concept
  - Distribute requirement items onto “Completeness Table” to check completeness and add more items to missing cells



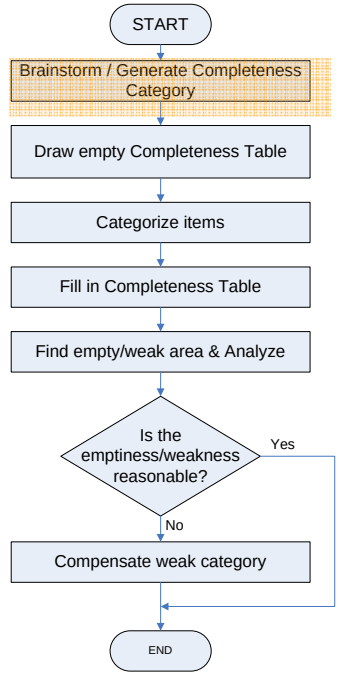
Regulation Completeness Analysis Method

- Flowchart

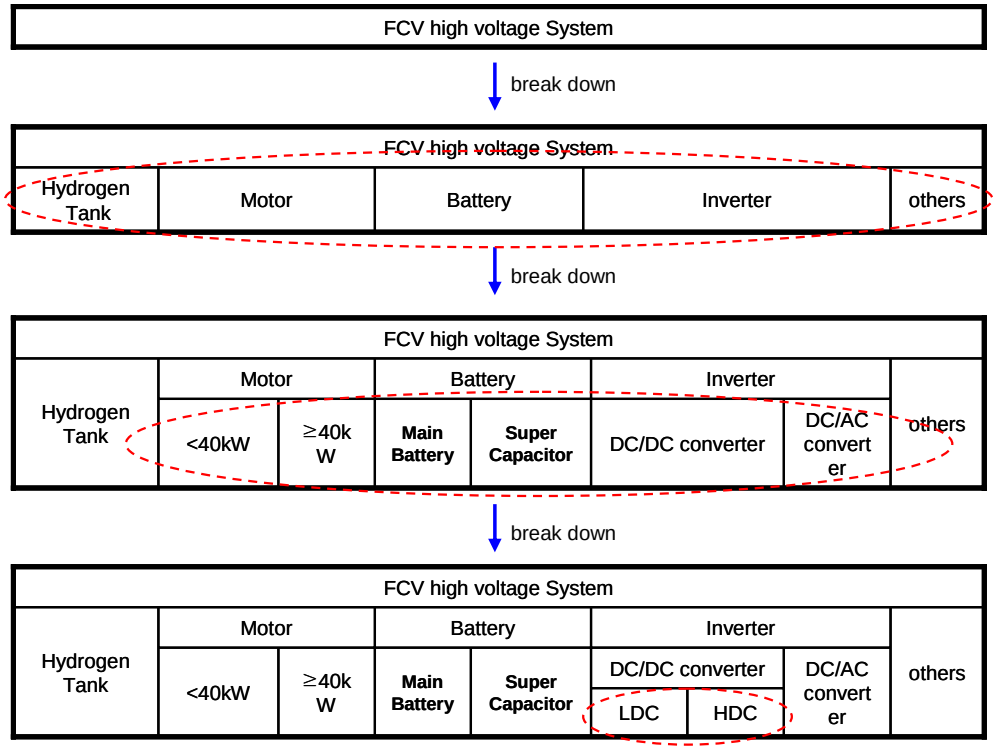


- Step 1: Brainstorm/Generate Completeness Category
- Step 2: Draw empty Completeness Table
- Step 3: Categorize items
- Step 4: Fill in Completeness Table
- Step 5: Analyze Completeness Table
- Step 6: Compensate weak category

Step 1: Brainstorm/Generate Completeness Category



- Brainstorm as many categories as possible which can be used to check the completeness of requirement items
  - Find categories
  - Break down each category to form a hierarchical structure
    - Break down as far as possible until basic elements are found
    - lowest sub category



Step 1: Brainstorm/Generate Completeness Category (Cont'd)

- Examples
  - Human
  - FCV high voltage system
  - Insulation
  - Vehicle state

Human						
User		Manufacturer			Supply Station Worker	
Driver	Passenger	Designer	Worker	Maintenance Man	Hydrogen	Battery

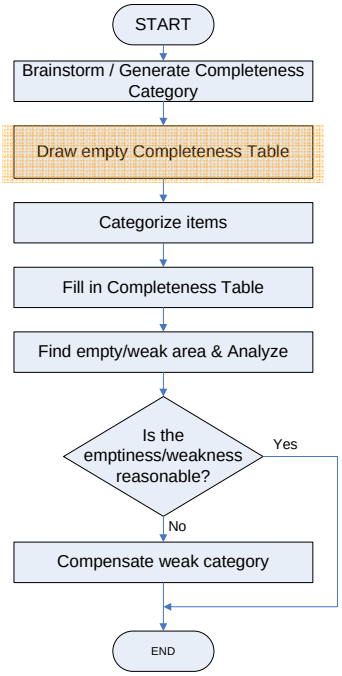
FCV high voltage System								
Hydrogen Tank	Motor		Battery		Inverter			others
	<40kW	≥40kW	Main Battery	Super Capacitor	DC/DC converter		DC/AC converter	
					LDC	HDC		

Insulation							
Human					Vehicle		
Gloves	Shoes	Clothes	Glass	Helmet	Jacket	Equipment case	Connector body

Vehicle State		
Parking	Idleness	Driving

Step 2: Draw Blank Completeness Table

- Select one category and draw Completeness Table
  - Make cells which can be filled with item numbers
- Example
  - Human category
    - All human who could possibly be related to FCV



Human						
User		Manufacturer			Supply Station Worker	
Driver	Passenger	Designer	Worker	Maintenance Man	Hydrogen	Battery

Place to be filled with item numbers

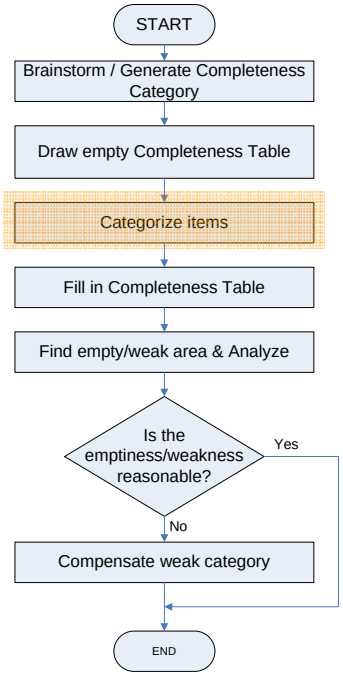
Step 3: Categorize items

- Assign numbers to every requirement items of the item pool for every axis
  - Regulation items are categorized by basic elements
  - Example (Using Microsoft Excel)
    - Human category
      - driver, passenger, designer, worker, maintenance man, hydrogen station worker, battery station worker

N	Items	Human
40	When battery is put back into the car, we should wait at least XX minutes until the motor is turned on.	Driver
41	When debugging with motor an additional button which could cut off all the electricity at one press should be available.	Maintenance man
42	When debugging with inverter an additional button which could cut off all the electricity at one press should be available.	Maintenance man
43	When debugging with battery an additional button which could cut off all the electricity at one press should be available.	Maintenance man
44	Cable connected to motor input & out should follow the following color rule (0 – XXV White, XXV – XXV Green, XXV – XXV Blue, Above XXV Red)	Maintenance man
45	Cable connected to battery input & out should follow the following color rule (0 – XXV White, XXV – XXV Green, XXV – XXV Blue, Above XXV Red)	Maintenance man
46	Cable connected to inverter input & out should follow the following color rule (0 – XXV White, XXV – XXV Green, XXV – XXV Blue, Above XXV Red)	Maintenance man
47	When soldering white color cable the soldering point should not change the insulation thickness by XX mm	Manufacturer
48	When soldering green color cable the soldering point should not change the insulation thickness by YY mm	Manufacturer
49	When soldering blue color cable the soldering point should not change the insulation thickness by ZZ mm	Manufacturer
50	When soldering red color cable the soldering point should not change the insulation thickness by TTmm	Manufacturer
51	Chassis should be grounded at the same level with test equipment when motor debugging is behaved	Designer
52	Chassis should be grounded at the same level with test equipment when inverter debugging is behaved	Designer
53	Chassis should be grounded at the same level with test equipment when battery is taken out from the car	Designer
54	Driver should not keep on driving when battery is lower than XXX% of all the powers	Driver
55	LED indicator which indicates the power for motor should be installed, on means the motor is running.	Designer
56	LED indicator which indicates the power for battery should be installed, on means the battery is running.	Designer
57	LED indicator which indicates the power for inverter should be installed, on means the inverter is running.	Designer
58	Motor should not be turned on when fuel is imported to hydrogen tank	Designer
59	Battery should be cut when fuel is imported to hydrogen tank	Designer

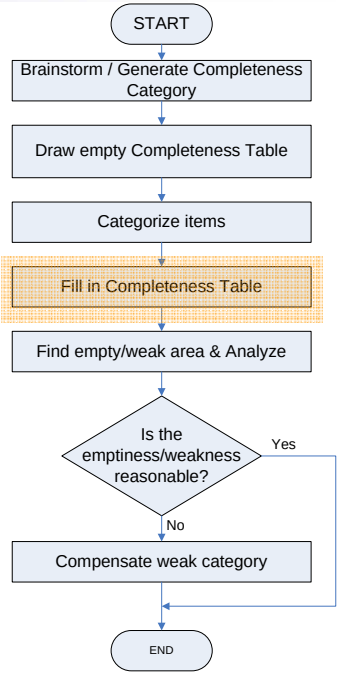
Human category items

Human category



Step 4: Fill in Completeness Table

- Place all requirement item numbers in the Completeness Table
  - For each requirement item, check elements of the category
  - Place requirement item number into cells in the Completeness Table



N	Items	Human
40	When battery is put back into the car, we should wait at least XX minutes until the motor is turned on.	Driver
41	When debugging with motor an additional button which could cut off all the electricity at one press should be available.	Maintenance man
42	When debugging with inverter an additional button which could cut off all the electricity at one press should be available.	Maintenance man
43	When debugging with battery an additional button which could cut off all the electricity at one press should be available.	Maintenance man
44	Cable connected to motor input & out should follow the following color rule (0 – XXV White, XXV – XXV Green, XXV – XXV Blue, Above XXV Red)	Maintenance man
45	Cable connected to battery input & out should follow the following color rule (0 – XXV White, XXV – XXV Green, XXV – XXV Blue, Above XXV Red)	Maintenance man
46	Cable connected to inverter input & out should follow the following color rule (0 – XXV White, XXV – XXV Green, XXV – XXV Blue, Above XXV Red)	Maintenance man
47	When soldering white color cable the soldering point should not change the insulation thickness by XX mm	Manufacturer

Human						
User		Manufacturer			Supply Station Worker	
Driver	Passenger	Designer	Worker	Maintenance Man	Hydrogen	Battery
40		1,2,3,7,8,9,12,13,14,15,18,19,20,21,22,23,24,25,26,28	4,5,6,10,11,16,17,27,29,	30,32,33,35,36,38,39,41		31,34,37

Step 4: Fill in Completeness Table (Cont'd)

- Example of Completeness Table #1
  - Human
    - User: Driver, Passenger
    - Manufacturer: Designer, Maker, Maintenance man
    - Supply Station Worker: Hydrogen, Battery

Human (86)						
User (4)		Manufacturer (77)			Supply Station Worker (5)	
Driver (4)	Passenger (0)	Designer (32)	Worker (26)	Maintenance Man (19)	Hydrogen (2)	Battery (3)
40,54,58,59		1,2,3,7,8,9,12,13,14,15,18,19,20,21,22,23,24,25,26,28,55,56,57,67,68,69,76,77,78,79,80,84	4,5,6,10,11,16,17,27,29,44,45,46,47,48,49,50,66,70,71,72,73,74,75,81,82,83	30,32,33,35,36,38,39,41,42,43,51,52,53,60,61,62,63,64,65	83,84	31,34,37

Human category

Step 4: Fill in Completeness Table (Cont'd)

- Example of Completeness Table #2
  - Insulation
    - Human: Gloves, Shoes, Clothes, Glass, Helmet
    - Vehicle: Jacket, Equipment case, Connector body

Insulation (22)							
Human (10)					Vehicle (12)		
Gloves (3)	Shoes (7)	Clothes (0)	Glass (0)	Helmet (0)	Jacket (7)	Equipment case (5)	Connector body (0)
31,32,33	34,35,36, 37,38,39, 83				5,27,29,47, 48,49,50	6,10,11,16,17	

Insulation category

Step 4: Fill in Completeness Table (Cont'd)

- Example of Completeness Table #3
  - FCV system
    - Hydrogen tank. Motor, Battery, Inverter, Chassis, General

FCV System (86)					
Hydrogen Tank (11)	Motor (23)	Battery (16)	Inverter (14)	Chassis (1)	General (21)
22,17,18,19,20,21,75,85,59,83,84	1,2,3,5,6,9,40,44,58,66,4,7,12,32,35,38,41,51,55,60,63,69,70	8,10,11,13,43,45,53,54,56,62,65,71,72,31,34,37	14,15,16,33,36,39,42,46,52,57,61,64,73,74,	28	23,24,25,26,27,29,30,47,48,49,50,67,68,76,77,78,79,80,81,82,86

FCV system category

Step 4: Fill in Completeness Table (Cont'd)

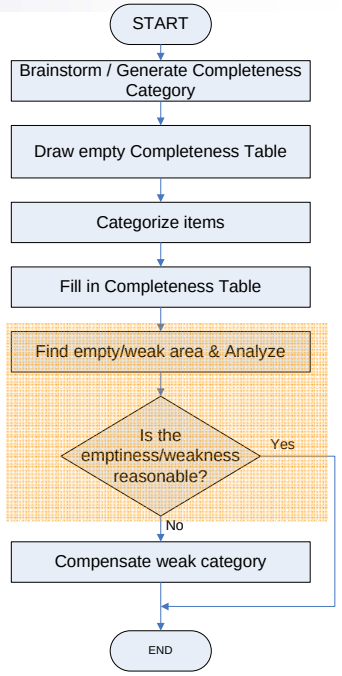
- Example of Completeness Table #4
  - Vehicle state
    - Parking (off state)
    - Idleness (not running state)
    - Driving (running state)

Vehicle State (86)		
Parking (56)	Idleness (29)	Driving (1)
1,2,3,4,5,6,8,9,10,11,13,14,15,16,17,18,19,21,23,24,25,26,27,29,31,34,35,36,37,40,44,45,46,47,48,49,50,55,56,57,58,59,66,67,68,69,73,75,76,80,81,82,83,84,85,86	7,12,20,22,28,30,32,33,38,39,41,42,43,51,52,53,60,61,62,63,64,65,70,71,72,74,77,78,79	54

Vehicle state category

Step 5: Analyze Completeness Table

- Mark blank cells or cells with small number of requirement items to analyze completeness of the requirement items
- Check whether it is necessary to add new requirement items
  - Mark red when needed, blue when not needed



Human (86)						
User (4)		Manufacturer (77)			Supply Station Worker (5)	
Driver (4)	Passenger (0)	Designer (32)	Worker (26)	Maintenance Man (19)	Hydrogen (2)	Battery (3)
40,54,58,59		1,2,3,7,8,9,12,13,14,15,18,19,20,21,22,23,24,25,26,28,55,56,57,67,68,69,76,77,78,79,80,84	4,5,6,10,11,16,17,27,29,44,45,46,47,48,49,50,66,70,71,72,73,74,75,81,82,83	30,32,33,35,36,38,39,41,42,43,51,52,53,60,61,62,63,64,65	83,84	31,34,37

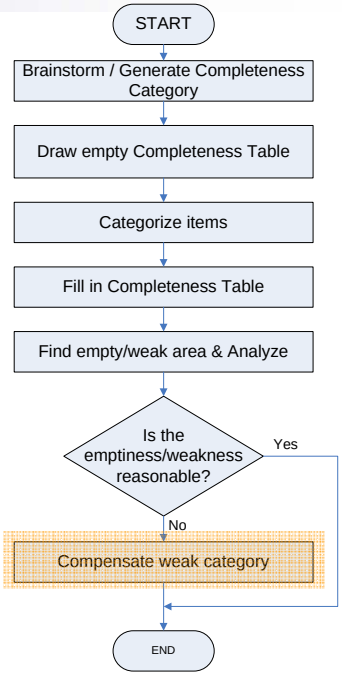
No need to add more items

Passenger does not need to follow any regulation

More items need to be added

Hydrogen and battery supply station workers need more requirement to prevent FCV high voltage accidents

Step 6: Compensate weak category



- Add additional requirement items to empty cells or cells with small amount of requirement items
  - Use similarity to generate new requirement items
    - Item 35 related to maintenance man can be used to generate new items (101,102) for battery supply station worker
      - 35: Wear insulation shoes when debugging with the motor (Insulation shoes should meet the electrical regulation XXX)

use similarity

      - new 101: Wear insulation shoes when charging electric vehicle battery (Insulation shoes should meet the electrical regulation XXX)

use expandability

      - new 102: Wear ESD preventive clothes when charging electric vehicle battery (ESD preventive clothes should meet the electrical regulation XXX)

Human (86)						
User (4)		Manufacturer (77)			Supply Station Worker (5)	
Driver (4)	Passenger (0)	Designer (32)	Worker (26)	Maintenance Man (19)	Hydrogen (2)	Battery (3)
40,54,58,59		1,2,3,7,8,9,12,13,14,15,18,19,20,21,22,23,24,25,26,28,55,56,57,67,68,69,76,77,78,79,80,84	4,5,6,10,11,16,17,27,29,44,45,46,47,48,49,50,66,70,71,72,73,74,75,81,82,83	30,32,33,35,36,38,39,41,42,43,51,52,53,60,61,62,63,64,65	83,84	31,34,37 101 102

Result of Regulation Completeness Analysis Method

- Result of the whole process
  - 86 items before process applied
  - 29 new items added after Regulation Completeness Analysis method

Items before process applied

Items after process applied

Nl	Items
74	Inverter should be working normally (temperature under XX °C) in XX frequency longer than XX hours.
75	Communication cable of Hydrogen tank should be shielded.
76	2 cables with XXV voltage input/output should be placed apart more than XX cm.
77	Power cable noise frequency should be in the range of XX KHz to XX MHz.
78	Antenna frequency should be in the range of XX KHz to XX MHz.
79	Shield effectiveness between each electric device should be more than XX dB.
80	No unwanted propagation of interference energy.
81	All wires should be shielded.
82	All shields of cables should be grounded.
83	Use tools with insulated handles at the end when charging the Hydrogen (Insulation shoes should meet the electrical regulation XXX)
84	When finish charging Hydrogen, we should wait at least XX minutes until the motor is turned on.
85	Indicator for voltage level generated in fuel cell stack must be mounted to the vehicle
86	Any cable which carries high voltage / large current should not pass near interior of vehicle, it should be seperated from the interior at least by XX cm
87	
88	
89	
90	
91	
92	
93	
94	
95	
96	

99	When Charging FCV Battery, Charge man must check whether FCV is idle.
100	Wear Insulated gloves for Tester when debugging with the battery.
101	Insulated Gloves for Tester should meet dielectric standard XX.
102	Wear Insulated Clothes for Tester when debugging with the battery.
103	Insulated Clothes for Tester should meet dielectric standard XX.
104	Caution Mark must be shown on enclosures in FCV according to the Article XX.
105	Enclosure Thickness must be XXcm.
106	Driver should not keep on Driving when he or she hear unusunal motor noise.
107	Temperature of FCV Motor should be controlled with in XX – XX C when driving.
108	Temperature of FCV Battery should be controlled with in XX – XX C when driving.
109	Humidity of FCV Motor should be controlled above XX% when driving.
110	Car Body should be grounded at the same level with test equipment when motor debugging is behaved
111	Car Body should be insulated with XX thinkness and YY material.
112	Communication wire noise frequency should be in the range of XX KHz to XX MHz.
113	Red wire must have shield effectiveness at least XX dB.
114	Green wire must have shield effectiveness at least YY dB.
115	Yellow wire must have shield effectiveness at least ZZ dB.

item pool before process applied

item pool after process applied

Added Item Pool

Contents

Conclusion

- Conclusion
  - Rulemaking process of electrical safety regulation for fuel cell vehicle high voltage systems is proposed
    - We propose Regulation Coverage Analysis Method
      - Find regulation missing areas with proposed “Distribution Graph”
      - Add more requirements by systematic brainstorming
    - We propose Regulation Completeness Analysis Method
      - Verify completeness with proposed “Completeness Table”
      - Add more requirements by inferring from other requirements