ASPECT2019///

Fallback Systems, Methods, Procedures and Resilience in Train Operation over Indian Railways

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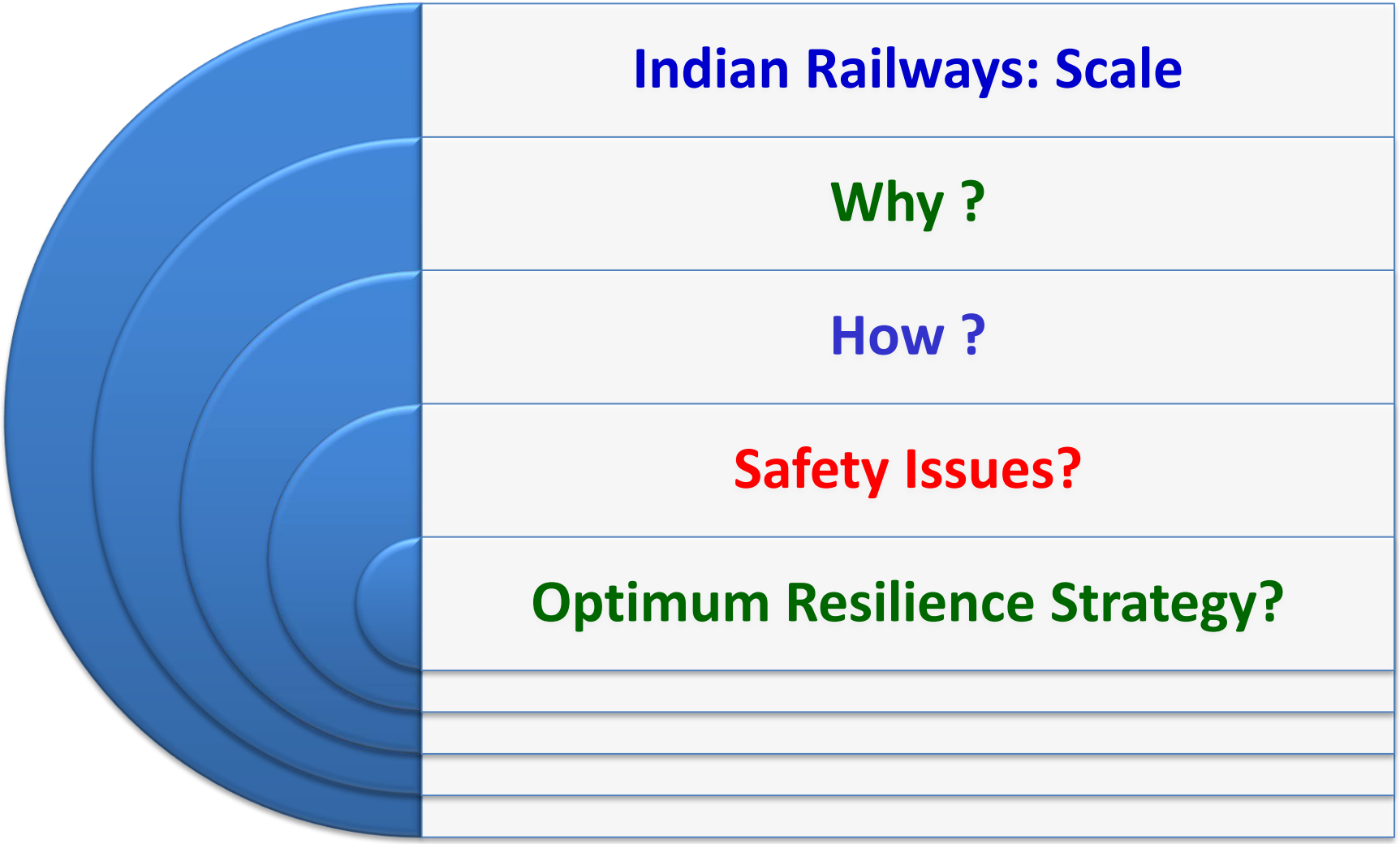
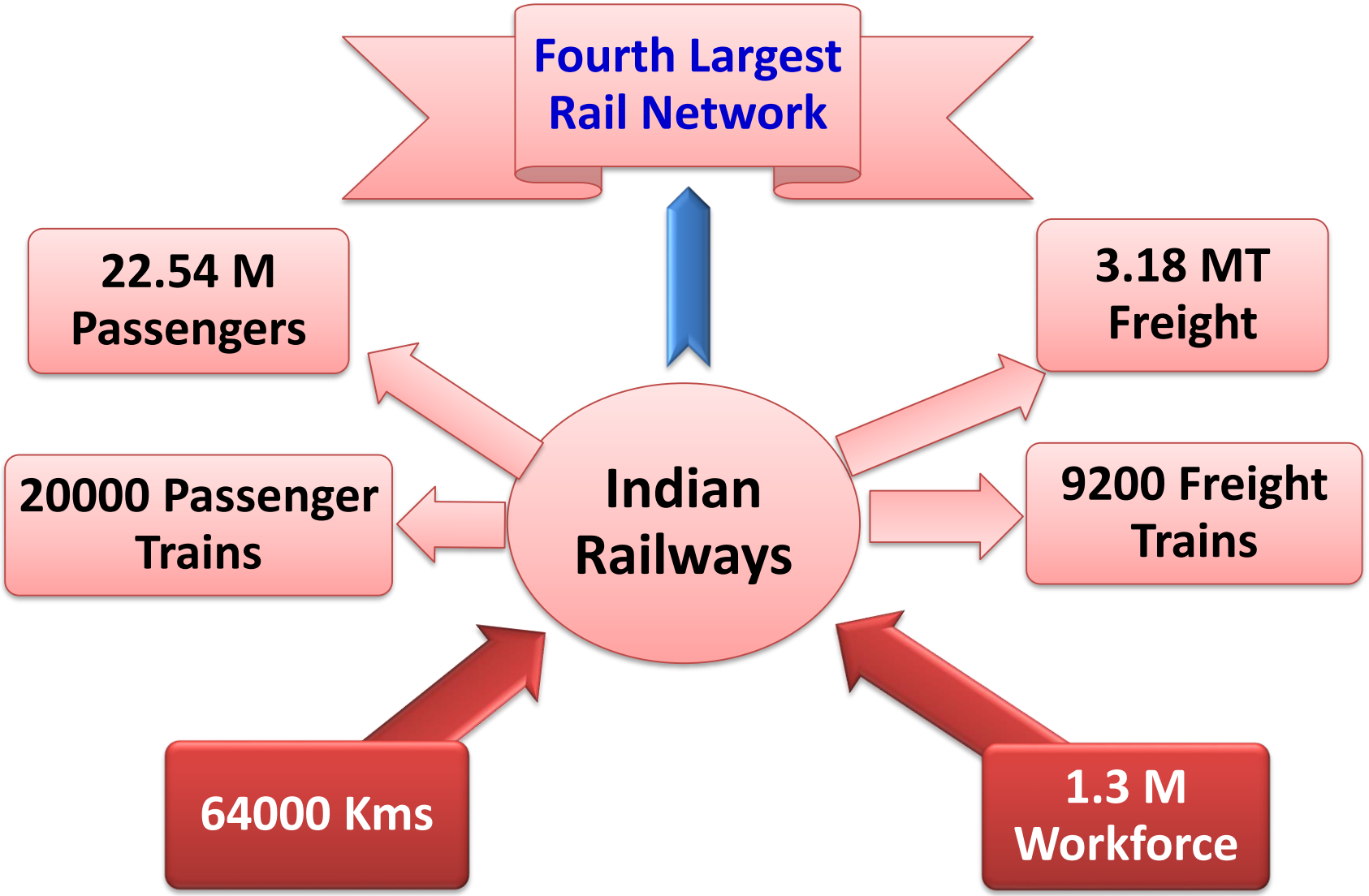
Fallback Systems, Method & Procedures



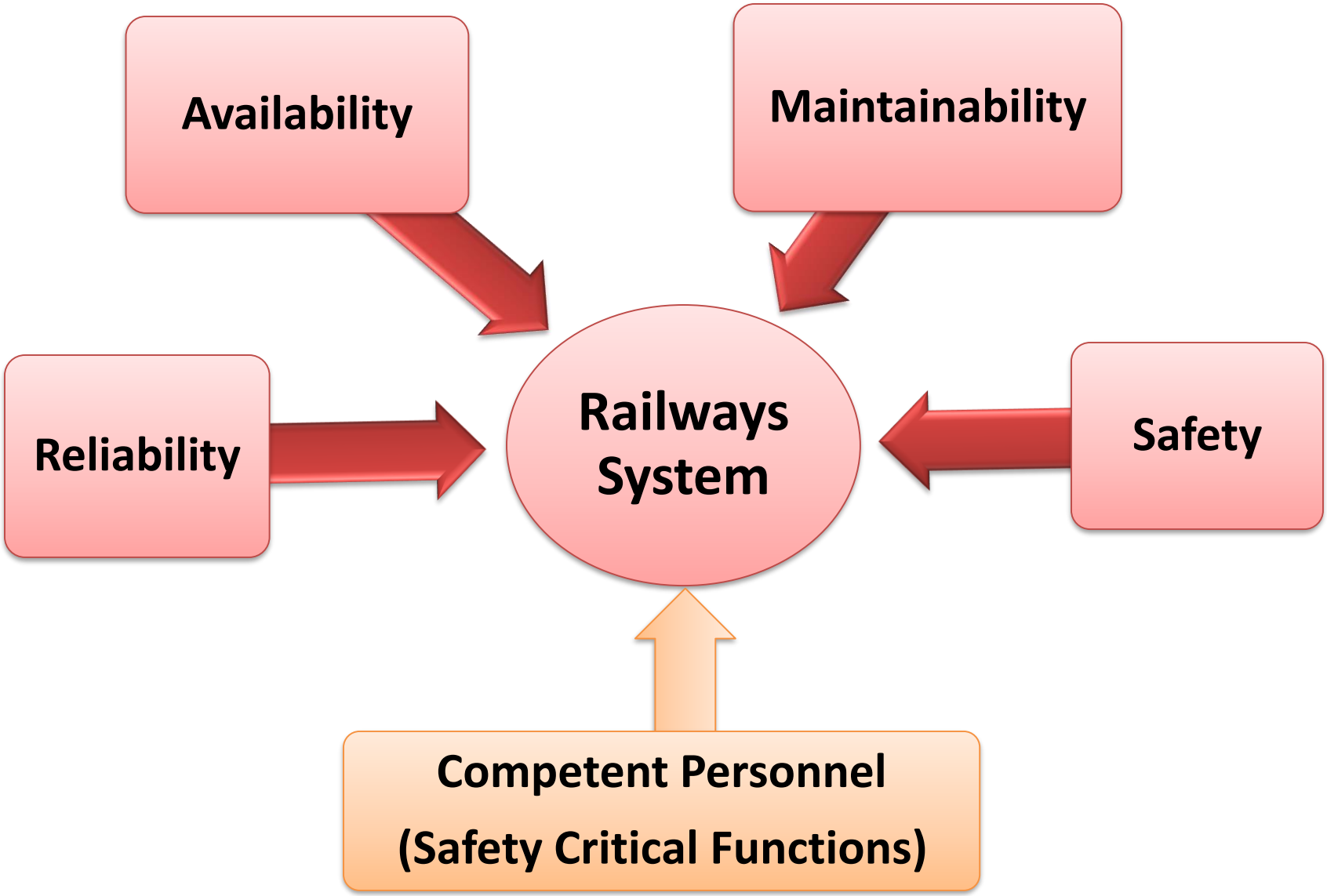
Indian Railways: Scale of Infra & Operation



Indian Railways: Traffic Growth & Capital Exp.

Year	No. of Passengers originating (in million)	Annual Growth Rate (in %)	Freight Traffic (in million tonnes)	Annual Growth Rate (in %)	Capital Expenditure (in million INR)
2013-14	8397	(-) 0.28	1058.81	4.40	557.39
2014-15	8224	(-) 2.06	1101.09	3.99	1101.09
2015-16	8107	0.11	1108.62	0.68	1108.62
2016-17	8116	0.11	1110.95	0.21	1511.1
2017-18	8286	0.21	1584.1	4.83	15.84.1

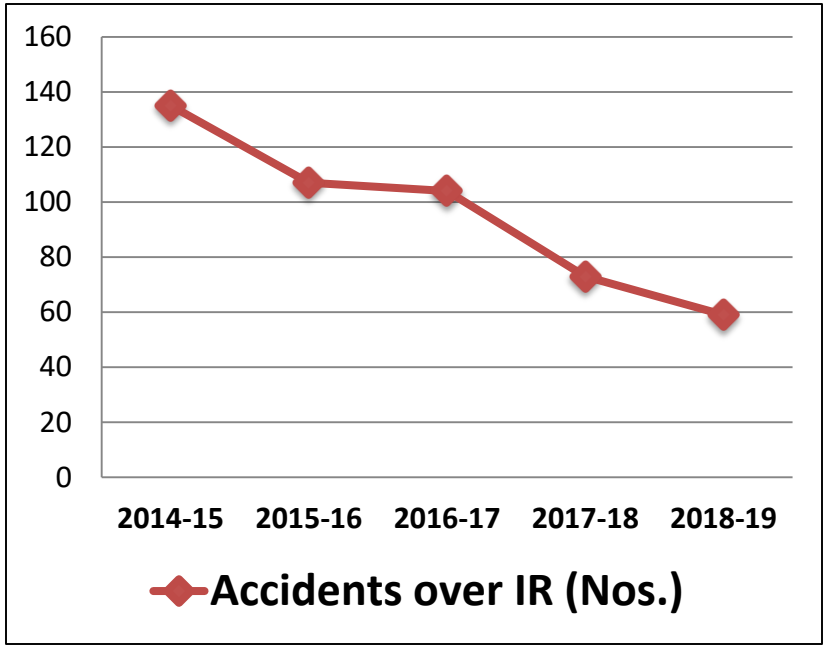
Why Fallback Systems, Method & Procedures?

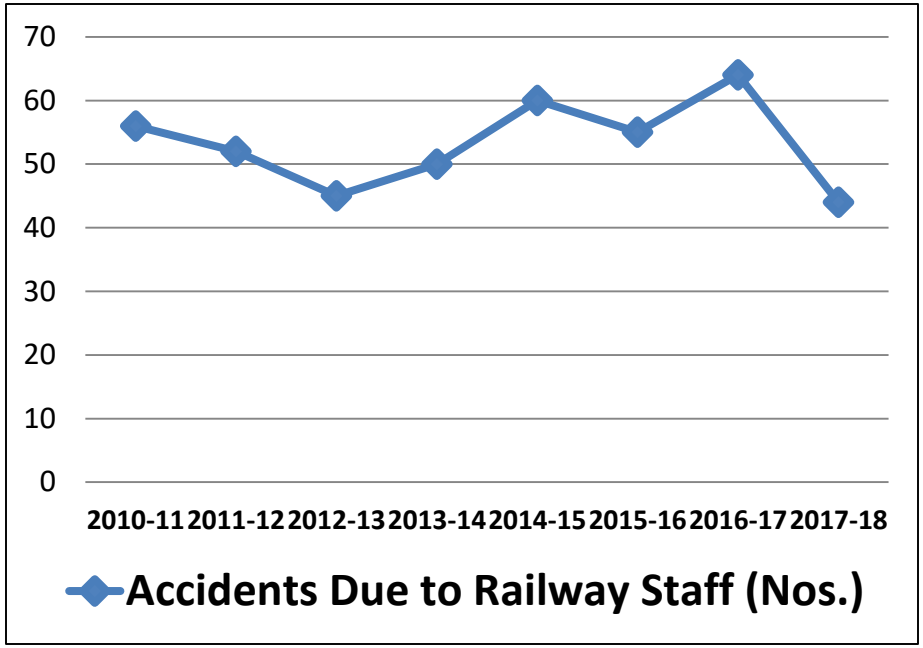


Indian Railways: Case for Resilience

- Growing network of rail infrastructure
- 1.3 million workforce involved in operation, maintenance & construction
- ✓ Increased Vulnerability in the safety performance
- Outage in the sub systems and slippages by human element, affects the:
  - ✓ Availability of Train Operation System and Safety
  - ✓ Society and Economy in terms of lost man hours
- Effective Fallback systems: reduced dependence on human & improved safety performance

Indian Railways: Case for Resilience





Year	Total Accidents (Nos.)	Accidents due to Failure of Railway Staff (Nos.)
2013-14	117	50
2014-15	135	60
2015-16	107	55
2016-17	104	64
2017-18	73	44

Railway Infrastructure

- Track
  - Rails
  - Bridges
  - Track Formation & Ballast
- Signalling
- Train Operation Communication
- Overhead Electric Equipments
- Traction
  - Electric
  - Diesel
- Rolling Stock

Infrastructure: Fallback Systems

❑ Track Defects Classification & Action

- ➢ **11 different types of Rails & 2 Weld defect**
- ➢ **Action after detection is defined in Manual for Ultrasonic Testing**
- ➢ **UIC system of Rail & Weld defect classification adopted over IR**

✓ IMR: Immediate Removal required; **Speed restriction of 30 Kmph** or more and continued till replaced.

✓ OBS: To be kept under Observation with Joggle fish plated joint

❑ Bridge Defects Classification & Rehabilitation

- ➢ **Category-I: requiring immediate rehabilitation**
- ➢ **Category-II: to be kept under observation and rehabilitation on a programmed basis.**

✓ Group I Distressed Bridges: Speed restriction of max. 15 Kmph

✓ Group II Distressed Bridges: Speed restriction of 25 - 50 Kmph with increased frequency of inspections

❑ Track Formation & Ballast

Infrastructure: Fallback Systems

❑ Signalling

Capacity enhancement by incorporating the flexibility and eliminating the Human element from the train operation

- **Degraded Mode of Signalling**
  - ✓ Calling On Signals
  - ✓ Emergency Electric Operation of points
  - ✓ Manual operation of points with Crank handles
- **Degraded Mode of Operation involving large extent Human element**
  - ✓ Paper Line Clear Ticket (PLCT) during defective Block instrument
  - ✓ Physical verification of last vehicle during defective LVCD
  - ✓ Train to stop at IBS, wait and proceed at restricted speed during defective IBS and communication with station master
  - ✓ Exchange of message with help of railway staff and conditional line clear
- **Standard Forms (24 in Nos.) for use are defined in General and Subsidiary Rules, 2005**

Infrastructure: Fallback Systems

❑ Overhead Electric Equipments

Fixed Infrastructure and provides power to locomotives

➢ Degraded Modes of working

Failure Modes	Degraded Mode Methods
Traction Sub Station failed	Feed extended from healthy TSS through Sectioning Post and number of trains restricted in the affected section
One Transformer at TSS failed	Stand by Transformer takes care of Load
Feeder Protection Relay not operated during OHE fault	Either Delta-I Relay or 25 KV Transformer protections operate
Pantograph strips bridges the live and dead zone at Sectional Insulator	Pantograph flash over relay operates & tripping protected
OHE of a siding failed	Isolated through Circuit breaker at TSS and main line OHE maintained in healthy condition

Infrastructure: Fallback Systems

❑ Traction System

- Both Diesel and 25 kV AC Electric traction with 12 class of Locomotives
- Diesel traction for resilience in train operation during failure of OHE, Electric locomotives disabling and for relief operations during accidents
- Homing loco sheds for inspection and maintenance as per schedule

➢ Degraded Modes of working: Electric locomotive

Failure Modes	Degraded Mode Methods
One Bogie with 3 Traction Motors Isolated	Operation is continued with Half Traction and Braking power
One Line Contactor failed and Isolated	Operation continued at 75% Power
One Traction inverter failed and Isolated	Operation continued at 83.3% Power
Auxiliary Converter failed and Isolated	Operation is continued with frequent checking of Auxiliaries
Harmonic Filter failed and Isolated	Speed reduces to 40 Kmph.

Infrastructure: Fallback Systems

➢ Degraded Modes of working: Electric locomotive

Failure Modes	Degraded Mode Methods
Horn or Whistle becomes defective during operation	Speed restricted to 40 Kmph. Day: Work up to destination Night: Only Clear the Block Section
Head light goes out of order	Speed restricted to 20 Kmph during night or poor visibility
Driving Cab fails	Drive from rear cab at max. 40 Kmph
Speedometer defective	Run with 10% less than MPS
Loco Pilot Incapacitated	Assistant Loco Pilot to clear the Block Section at max. Speed of 25 Kmph

Infrastructure: Fallback Systems

❑ Rolling Stock

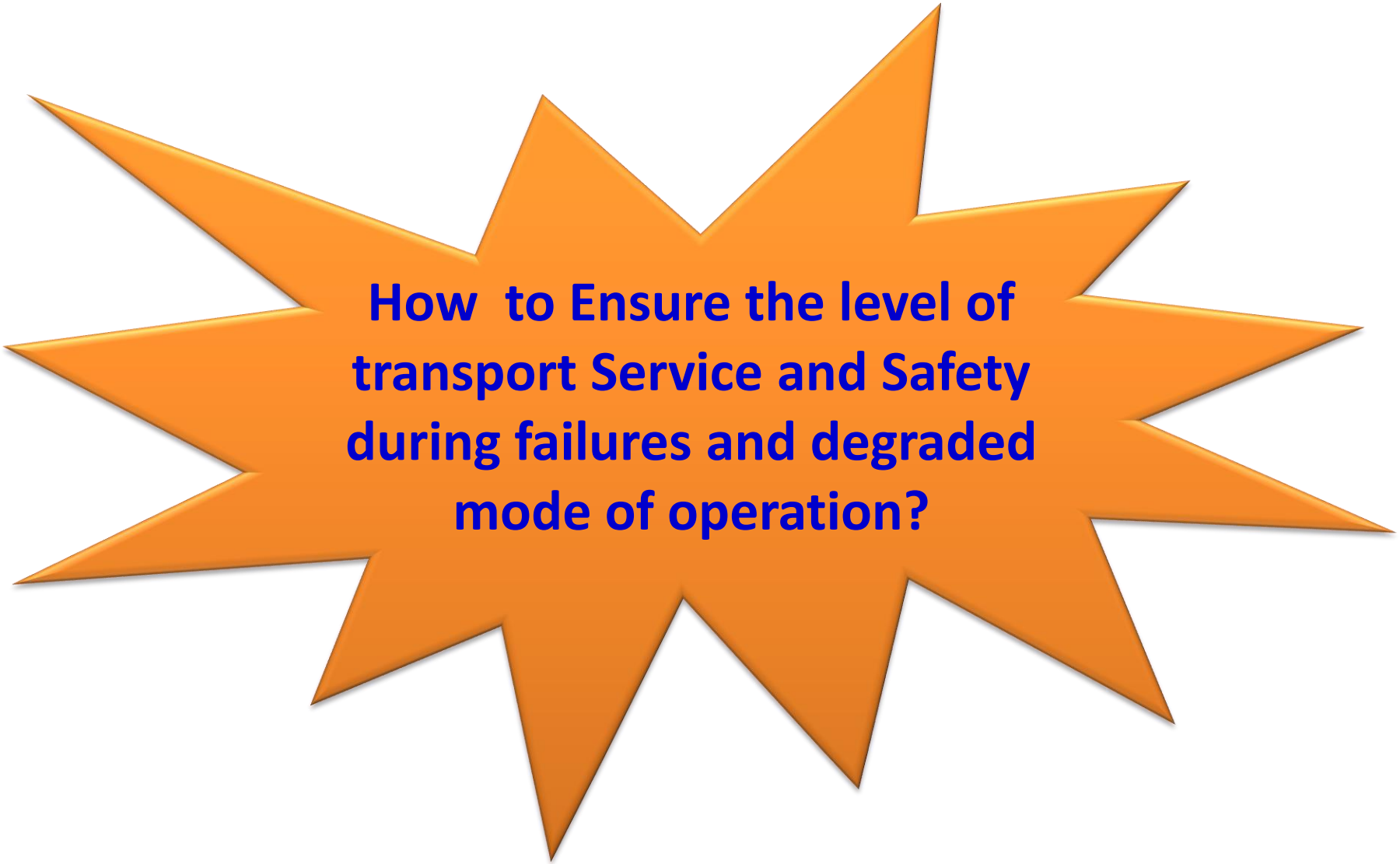
- Two different design of coaches; ICF and LHB with speed potential of 130 and 160 Kmph respectively
- 40 different designs of freight carrying wagons with speed potential varying from 60 – 100 Kmph
- Nominated Coaching depots for Primary maintenance as per schedule
- Examination of wagons by Freight Examination Points (FEP) and issue of Brake Power Certificate (BPC) with certain validity
- Overhauling by nearest Carriage & Wagon workshop
- System of rolling – in- examination at every 250 – 300 Kms in place
- Plays a very vital role in the detection of failures or deterioration in the parameters during run

Infrastructure: Fallback Systems

➢ Degraded Modes of working: Rolling Stock

Nature of Defects Observed	Speed Restriction imposed
Broken Spring in LHB Coaches	80 kmph
Broken Bolster Spring	60 kmph
Broken Axle Spring Primary directly attached to wheel set	60-80 kmph
Flat Tyres up to 50 mm LHB coach	80 kmph
Flat Tyre more than 60 mm ICF Coach	80 kmph
Failure of electrical equipments in passenger coaches	Emergency feed from adjoining coach, a second inverter and second feeder take care of full load

Biggest Challenge! before IR



Safety in Degraded Mode of Operation

- Systems, Methods and Procedures are designed to provide the same level of safety as the normal mode of operation.
- Involvement of human's in the process,
- Level of safety is dependent upon the error free implementation of methods, operation techniques and procedures by operators.
- Availability of fallback systems, documentation, knowledge and skill to correctly apply the procedures play a significant role in maintaining the better safety performance of IR as most of the accidents take place during a failure.
- Periodical medical test (PME), Psycho test and refresher training for operators and maintainers at prescribed schedule to keep them fit for the task.
- Supervision play crucial role in application of knowledge and skill by operators & maintainers during the failures and emergencies and deliver the services at same RAMS.

Conclusion

- Reliable rail transportation is the need of the hour for growing Indian population and expanding economy
- Limited application of the modern technology for condition monitoring of the infrastructure
- Heavy dependence upon the manual inspection, testing and measurement of track, signalling and operation,
- Human factor plays a crucial role in the utilisation of the full potential of the infrastructure, reliable and safe operation of trains and finally delivery of transportation services to the end user.
- Functioning of degraded mode of infrastructure, methods and procedures have a crucial role in maintaining train mobility in a safe and reliable manner

Availability of Fallback systems in good fettle and use of methods and procedures in an error free manner is the key.

This requires sustained inputs of training, knowledge, effective supervision and disciplined staff to achieve the objectives of the Indian Railways with resilience.

Thanks for your attention!