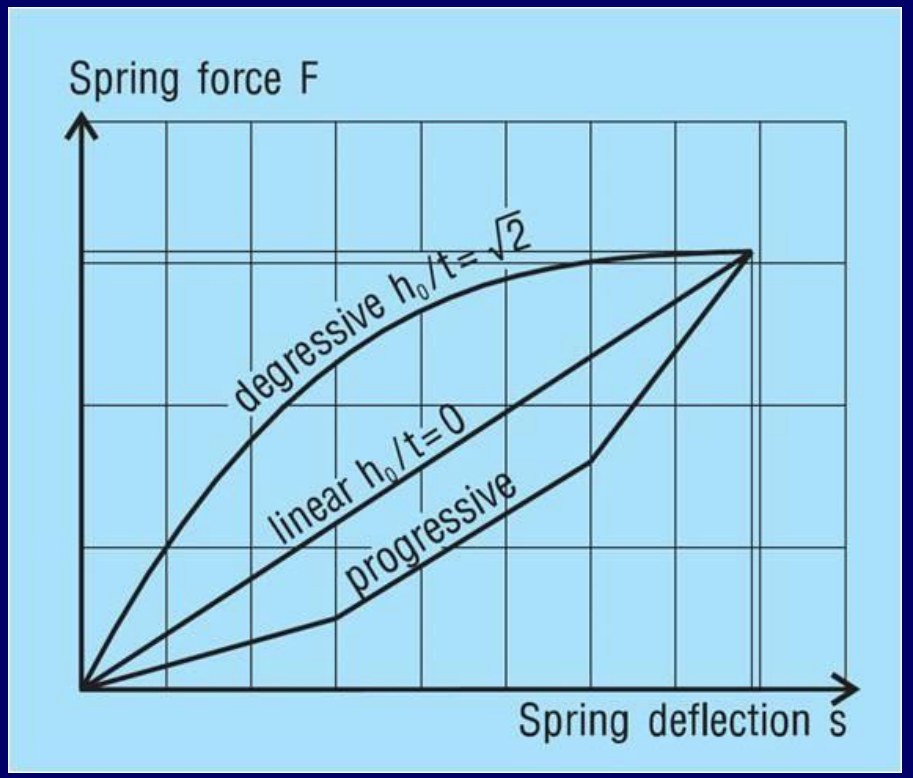
Name and Role of Bogie Components (including brake system)

Topics Covered

- Concept of suspension
- Concept of tractive effort and braking
- Requirements from suspensions + braking system
- Working of suspension systems
- Name and function of bogie components
- Understand the working of brake system.
- Name & function of Braking System Components
- The latest development in bogie+braking system

Concept of Suspension

- Spring Mechanism
  - Linear
  - Step/ non-linear
  - Bumps (Limiters)
  - Progressive spring characteristics



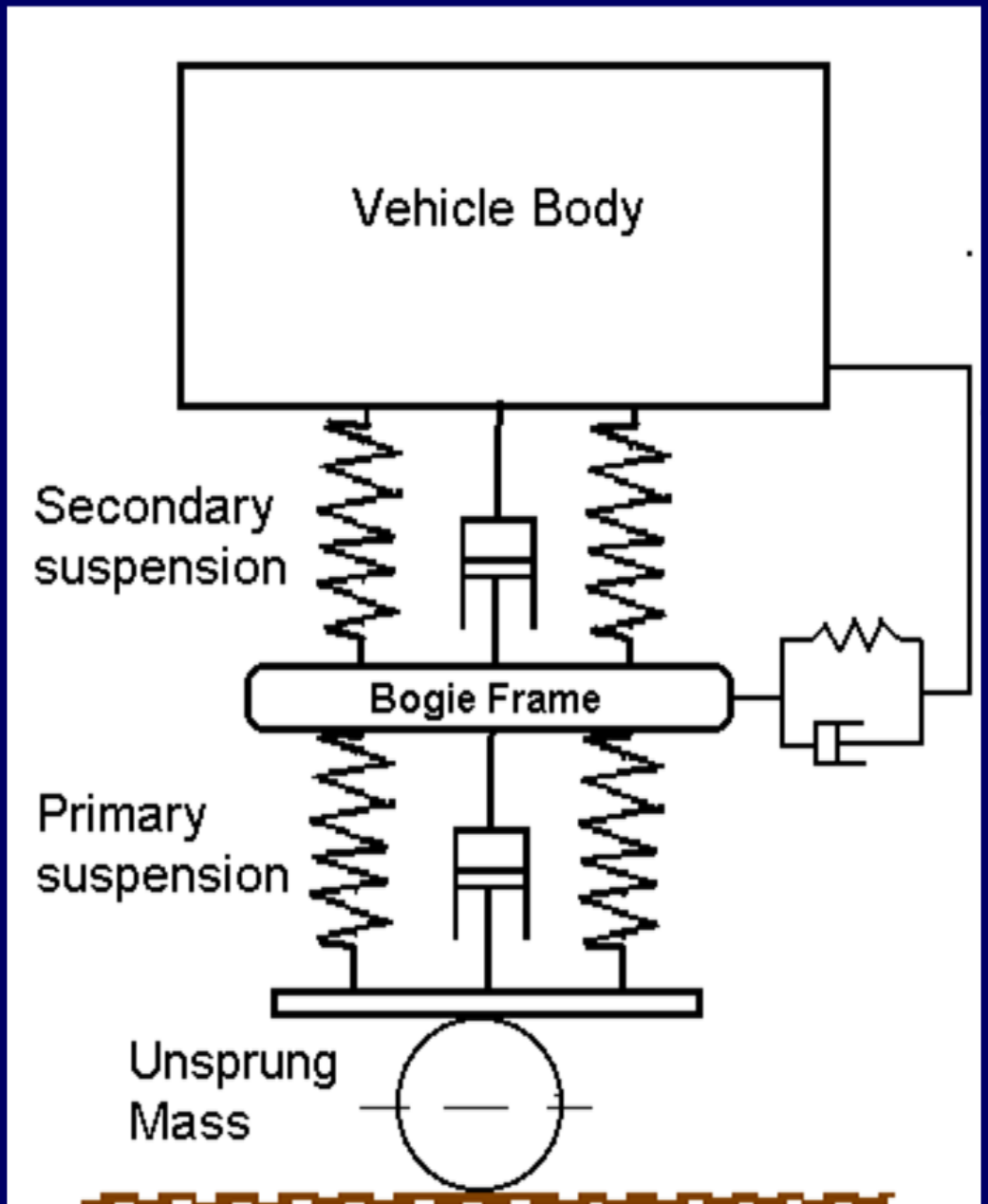
Spring Types

- Coil Springs
- Flexi-coil springs
- Air springs
- Solid Springs

Suspension Systems in Railways

- Single stage system: Consists either of
  - Primary suspension or
  - Secondary suspension
- Two stage suspension system : Both
  - Primary suspension and
  - Secondary.

Diagram: Two Stage Suspension System



Dampers/ Shock Absorbers

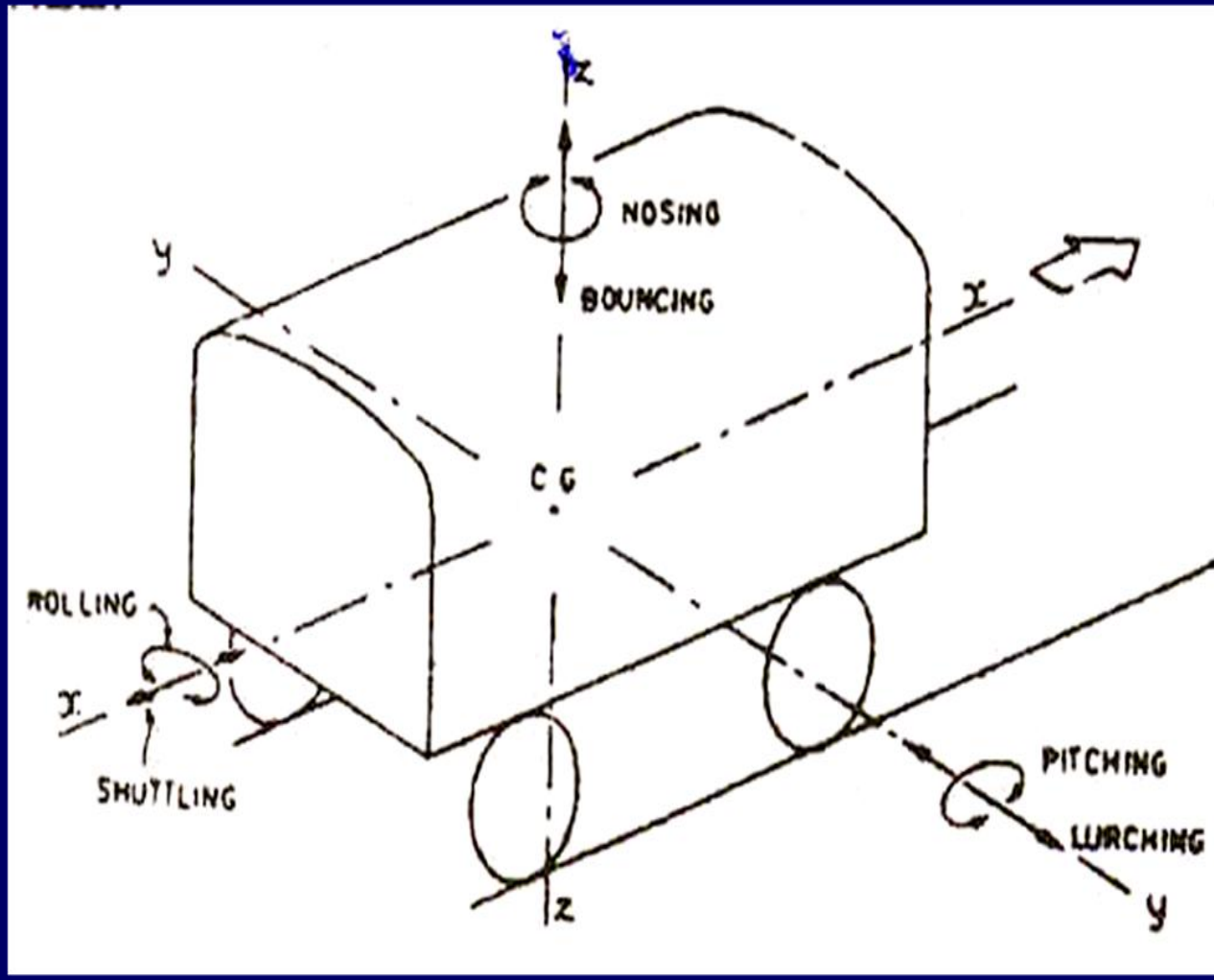
- Hydraulic
- Friction
- Pneumatic
- Rubber/ composite

Kinematic Elements in Suspension

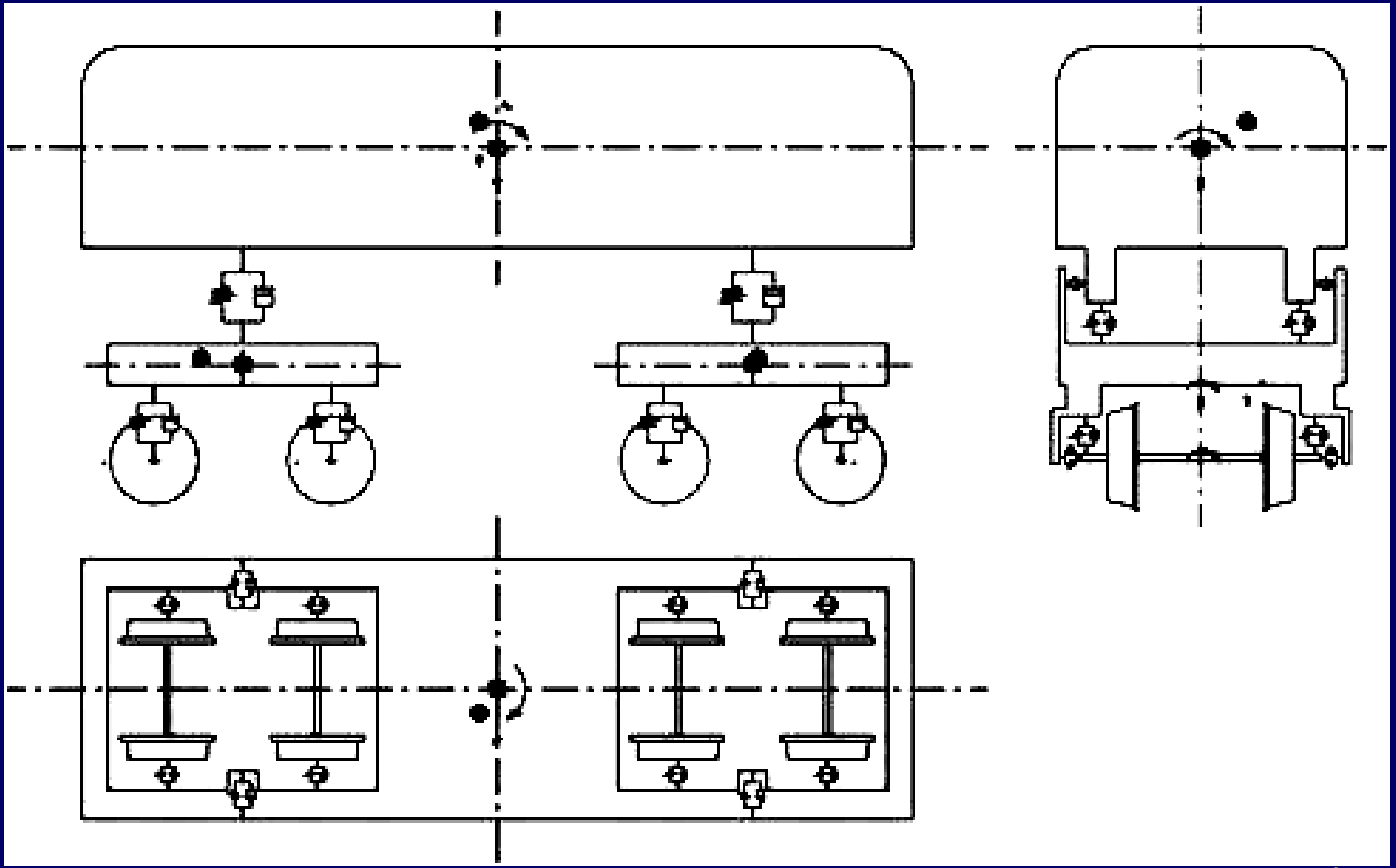
- Track
- Wheel-set
- Primary suspension
- Bogie frame
- Secondary suspension
- Lateral suspension
- Tractive & braking effort transfer components.

Simple DOF of a Single Body

- 3 linear
  - Shuttling
  - Lurching
  - Bouncing
- 3 rotational
  - Rolling
  - Pitching
  - Nosing or Yaw

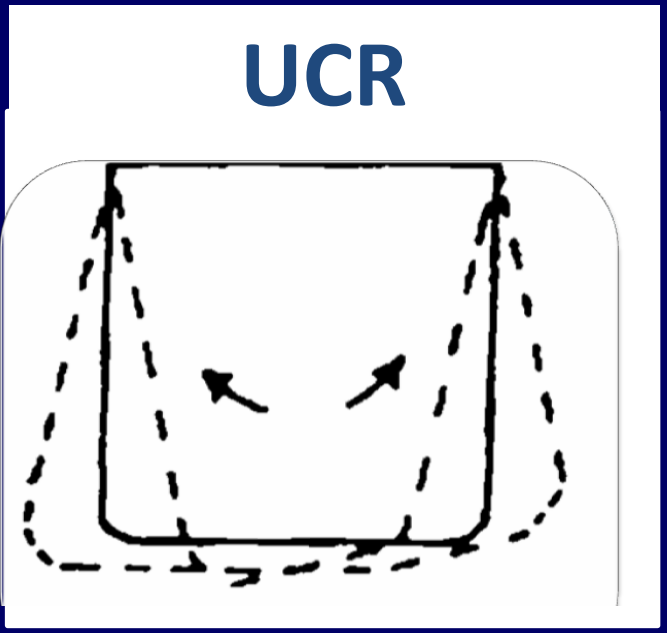


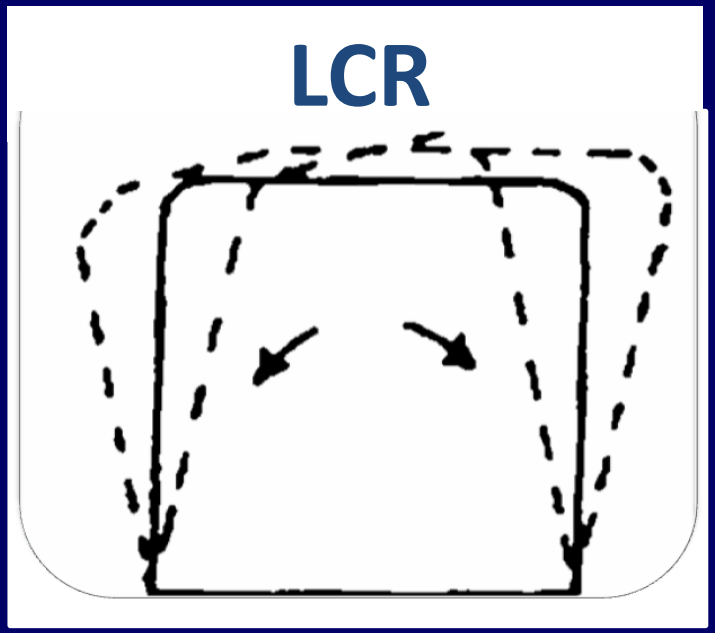
Complex Support of a Single Body



Roll and it's Prevention

- Effect of roll on human body
  - Type of roll: UCR and LCR
- Prevention not available in ICF bogie.
- Anti-Roll bar mechanism in LHB bogie.
- Air suspension system case.





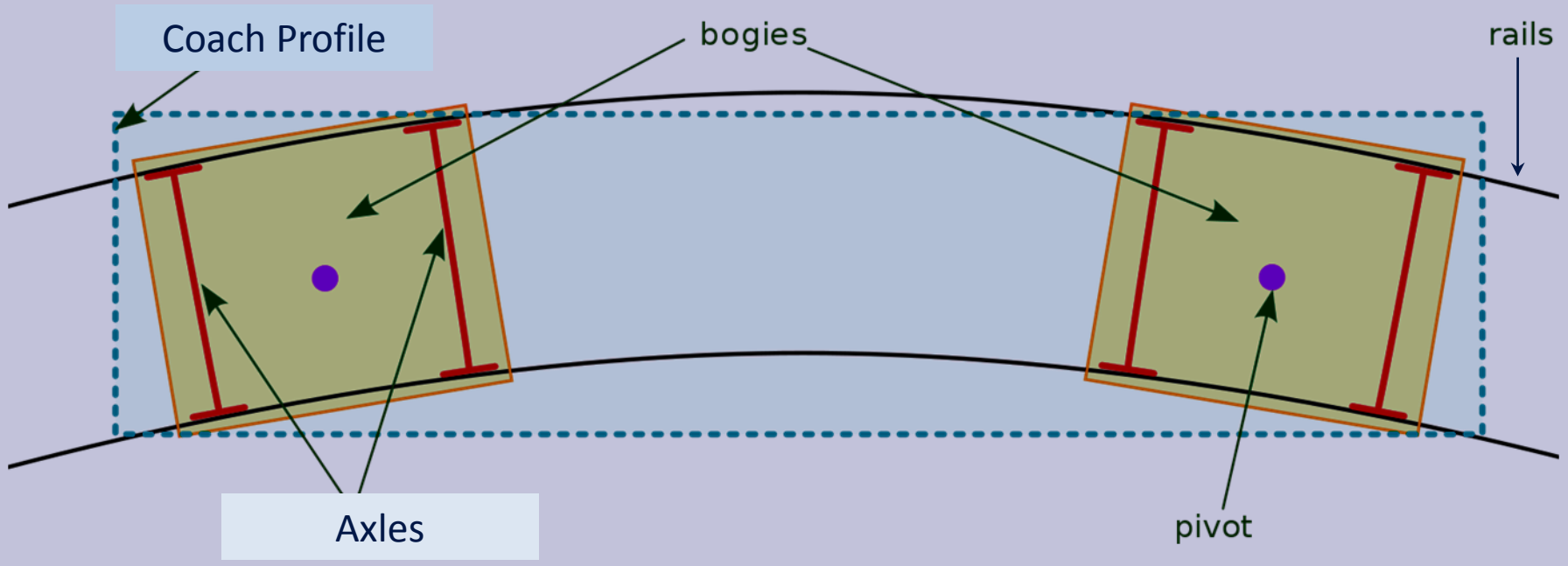
REQUIREMENTS FROM BOGIE

Requirements from a Bogie

- Linear/Curving requirement.
- Energy transmission and control:
  - Linear: vertical, lateral, longitudinal.
  - Rotational.
- Roll prevention requirement.
- Ability to filter out the irregularity between track and bogie.
  - Concept of offloading.
- Ability to bear the static load.

Linear/Curving requirements & Control

- Controlled clearance required



Lateral Energy Transfer Mechanism

- ICF
  - Spring-tilt mechanism with BSS Hanger & equalising stay arrangement at secondary suspension.
  - Much limited at primary suspension.
- LHB
  - Flexi coil springs at secondary suspension.
  - Control arm arrangement at primary suspension.
- Casnub
  - Much limited (spring nest & friction wedge block).

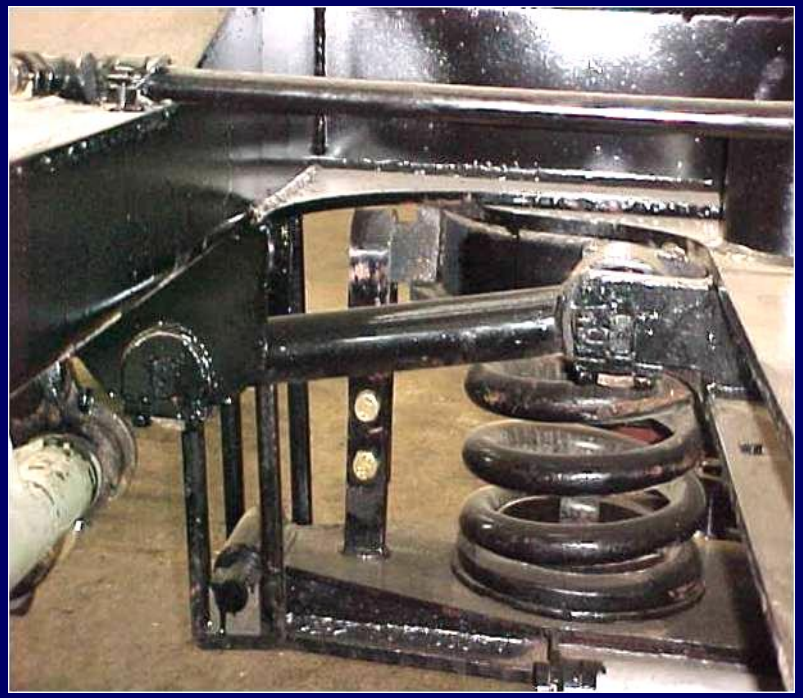
Longitudinal Load Transfer Mechanism

- Tractive/ Braking force transfer mechanism.
- Concept of traction centre.
- Effect of buffer height on traction centre.

Components for Longitudinal Load Transfer

- ICF
  - Centre pivot arrangement
  - Anchor links.
    - Anchor link silent block.
  - Rigid type axle guides.
- LHB
  - Body-bogie connections.
  - Traction assembly.
  - Control arm arrangement.

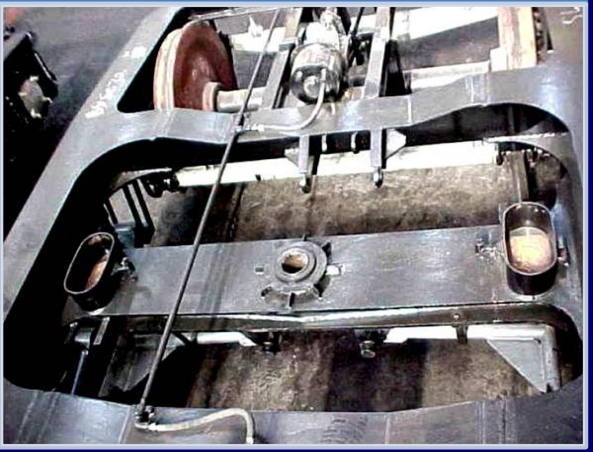
Anchor Link (ICF Coach)



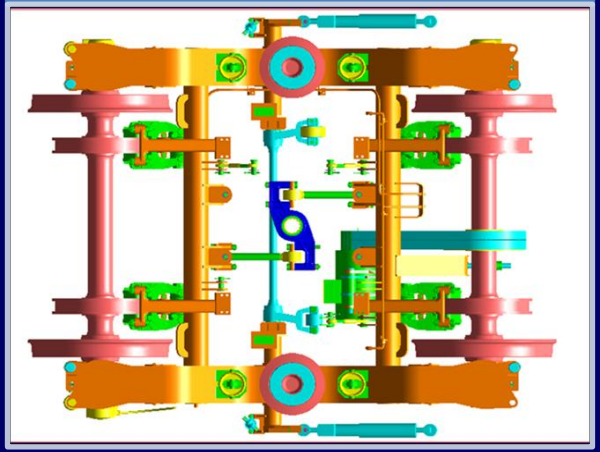
- Fitted with silent block.
- Transmits the tractive and braking forces.
- Can swivel universally
  - To permit the bolster to rise & fall and to sway sidewards.

Centre Pivot Arrangement

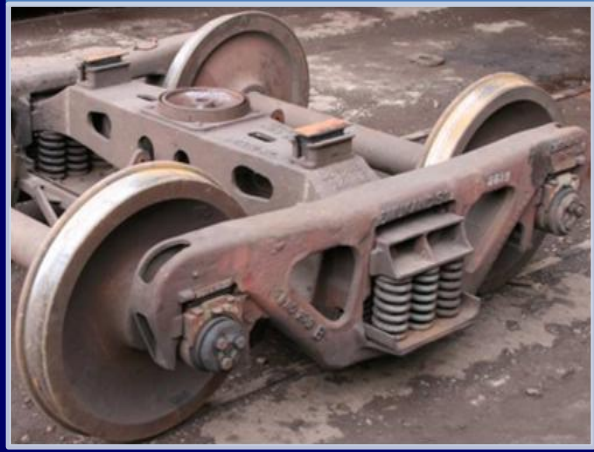
ICF



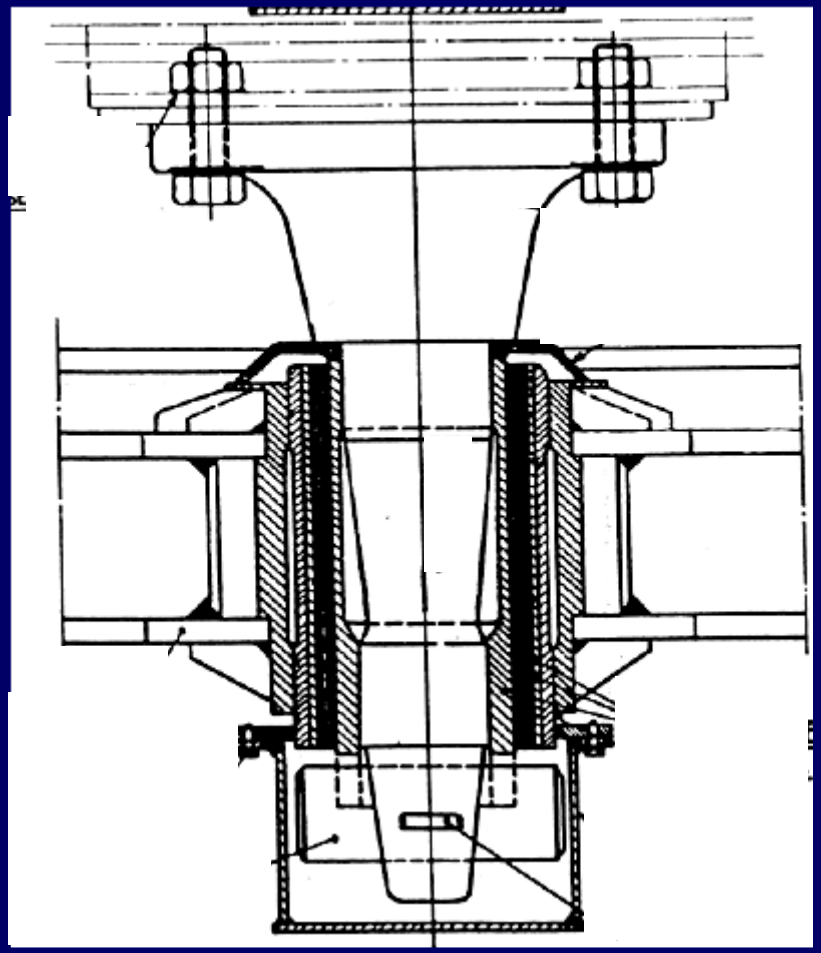
FIAT



CASNUB



Centre Pivot Arrangement (ICF Bogie)



- Facilitates body-bogie joint .
- Transmits the tractive & braking forces.
- Rubber silent block
  - Injection moulded type
  - Tends to centralise the bogie w.r.t. the body
  - To some extent, control and damp the angular oscillations of the bogies.

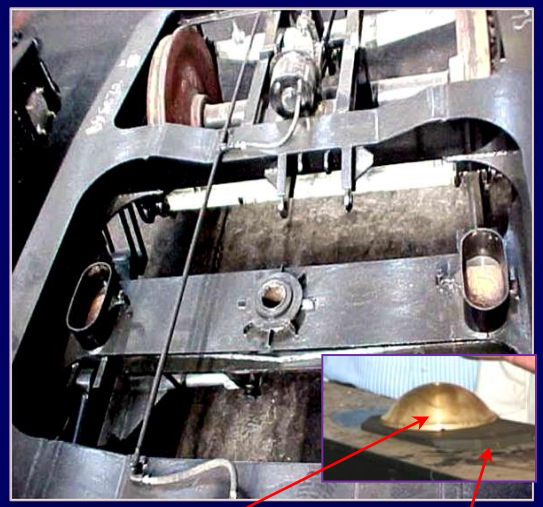
Springs and Off-loading

- Frame twist flexibility
  - 25 mm offload.
  - 50 mm offload.
- Softer secondary
  - Not possible due to space constraint in ICF.
  - Used in FIAT bogie.
- Variation in buffer height.

Static Load Transmission

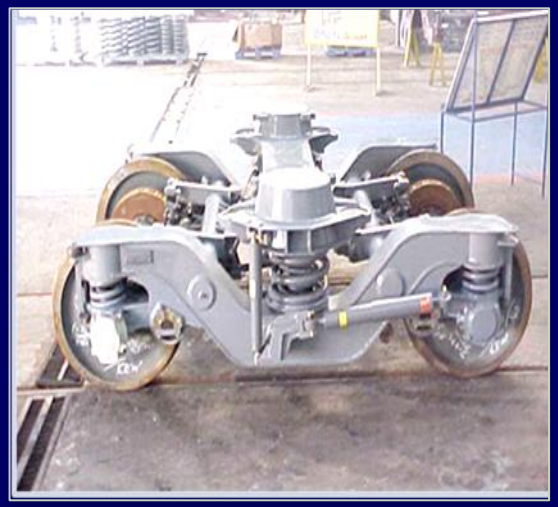
- Side Bearers and Centre Pivot

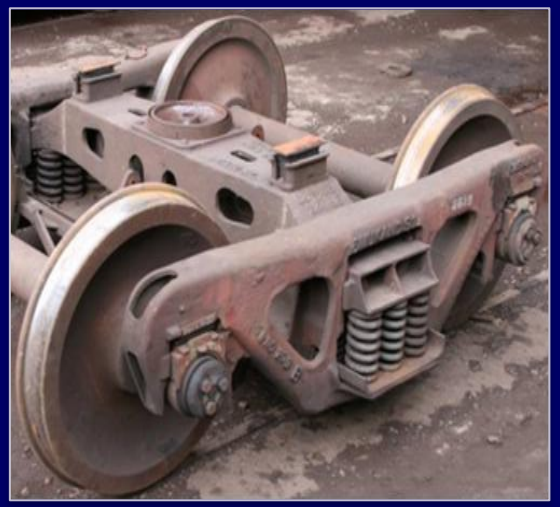
ICF Side Loaded	FIAT Side Loaded	CASNUB Centrally Loaded



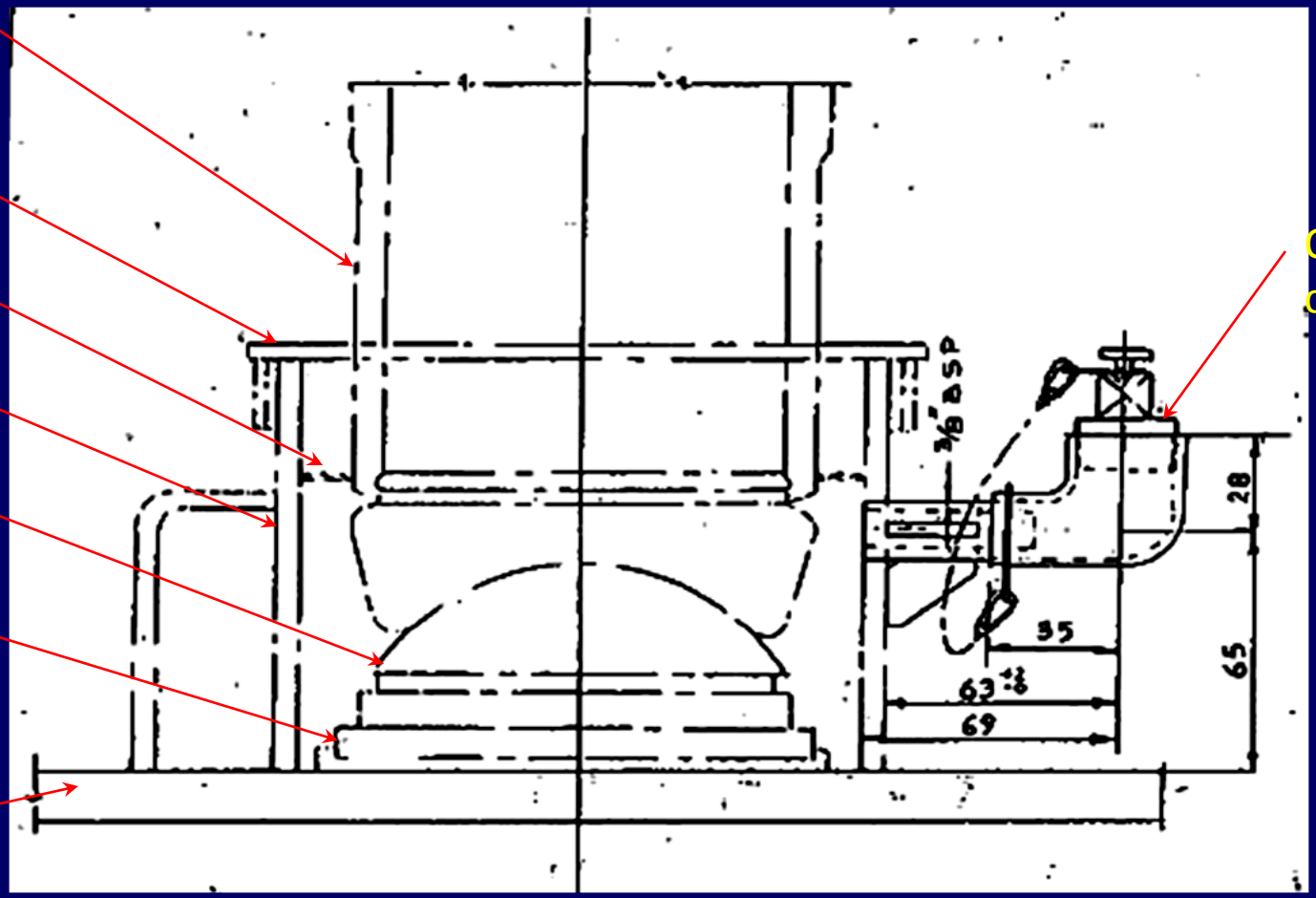
Wearing piece: hemispherical for self-aligning characteristic

wearing plate





Side Bearer Arrangement (ICF Coach)

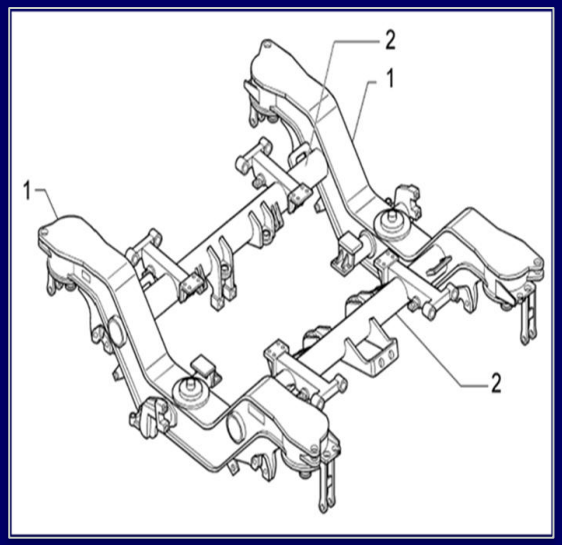


Bogie Frame

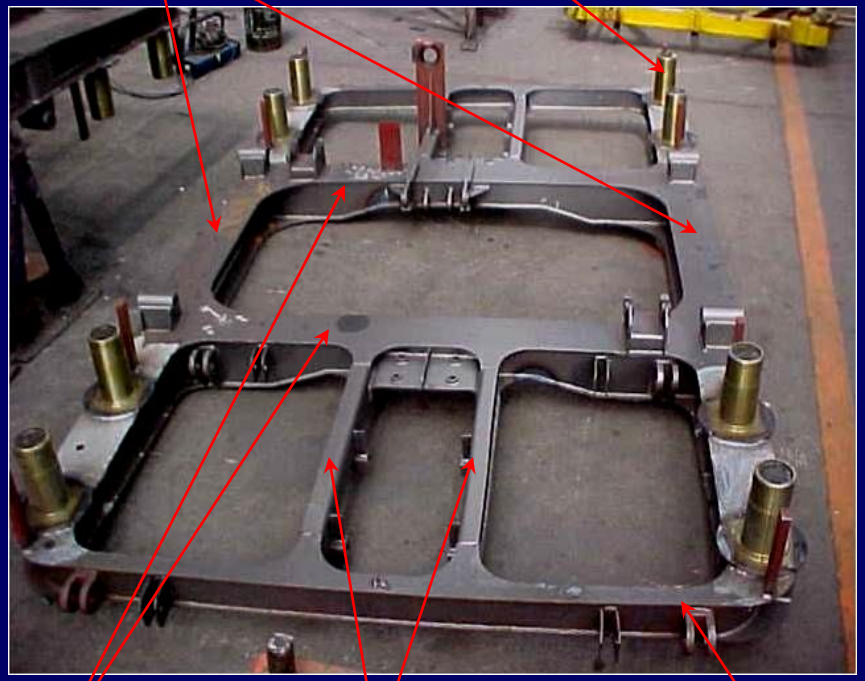
ICF

FIAT

CASNUB



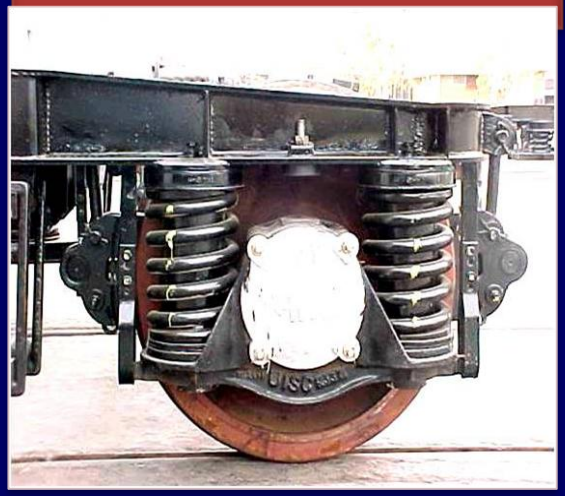
Bogie Frame with Axle Guides (ICF)



- Rigid type Consists of
  - 2 sole plates (side frames).
  - 2 headstocks.
  - 2 transoms at centre.
  - 4 longitudinals.
- 8 axle guides welded to the side frame with close dimensional accuracy.

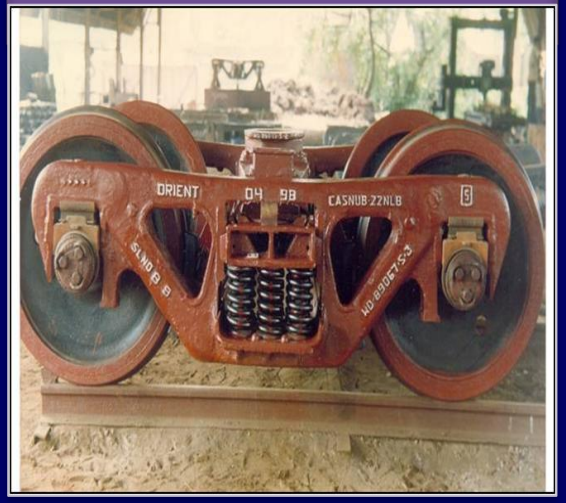
Axle Guide Arrangement

ICF



FIAT

CASNUB



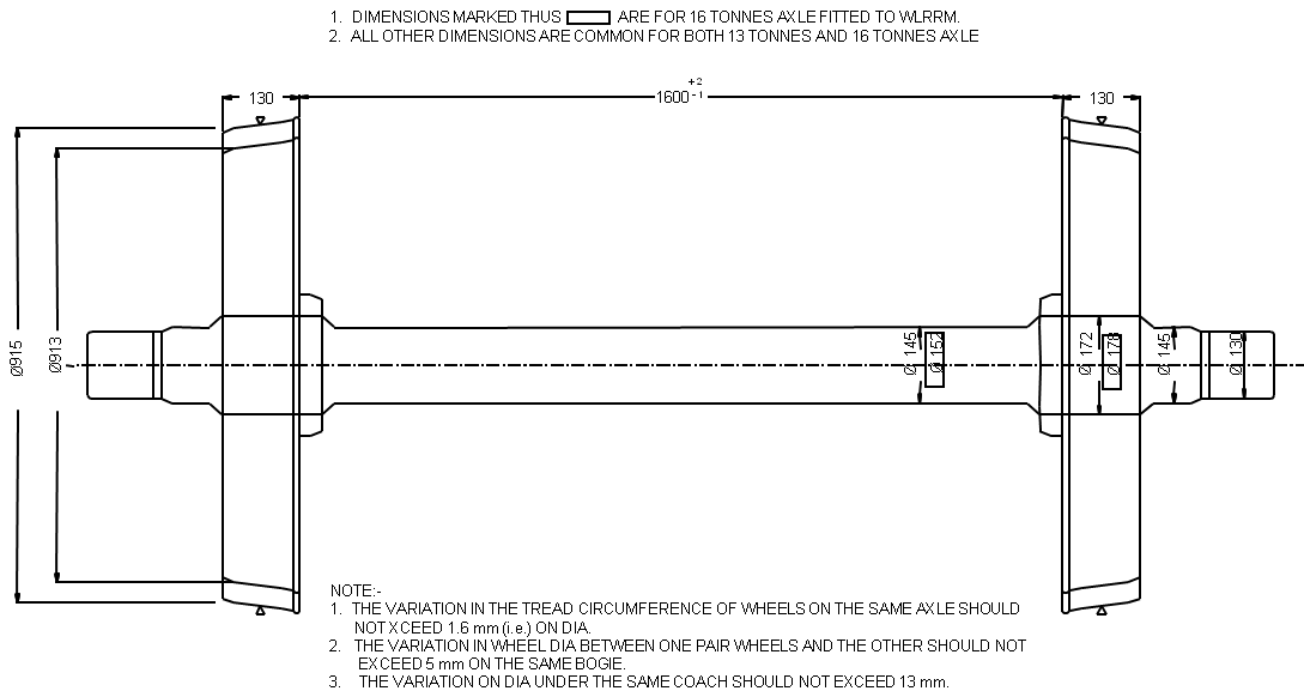
Function of Axle Guides (ICF)

- Guides the axle w.r.t. bogie frame laterally as well as longitudinally.
- Transmits tractive & braking force between bogie frame & axle box.
- In ICF, acts as a single acting hydraulic vertical shock absorber for primary spring.
- In FIAT bogie, provides control flexibility between frame and axle.

Axle Box Bearing

- CASNUB bogie
  - CTRB
- ICF bogie
  - Spherical type roller bearing with self-align feature.
    - Automatically adjust to the deviation in the centre line of the axle during run.
- FIAT bogie
  - CTRB

Wheel, Tread and Axle



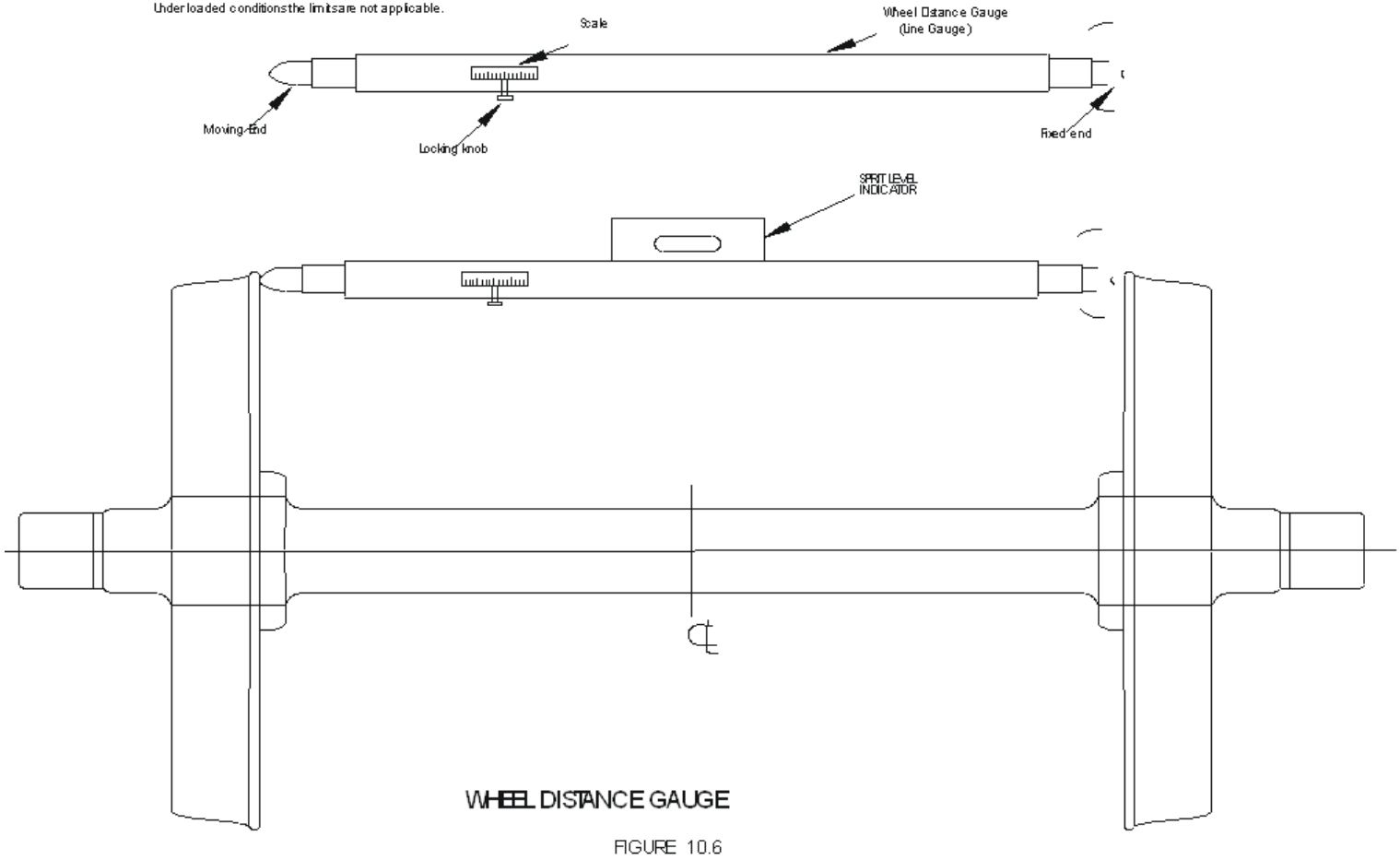
- Nomenclature
  - Axle
    - Journal
    - Collar
    - Wheel seat
  - Disc
    - Tread
    - Hub
    - Tyre profile

Wheel Gauge

Newly assembled wheel set should be checked for the distance between inner face of wheel i.e. 1600 +2/-1 mm using Wheel Distance Gauge.

The wheels to be gauged on a level track after taking off from coaching vehicle.

Under loaded conditions the limits are not applicable.

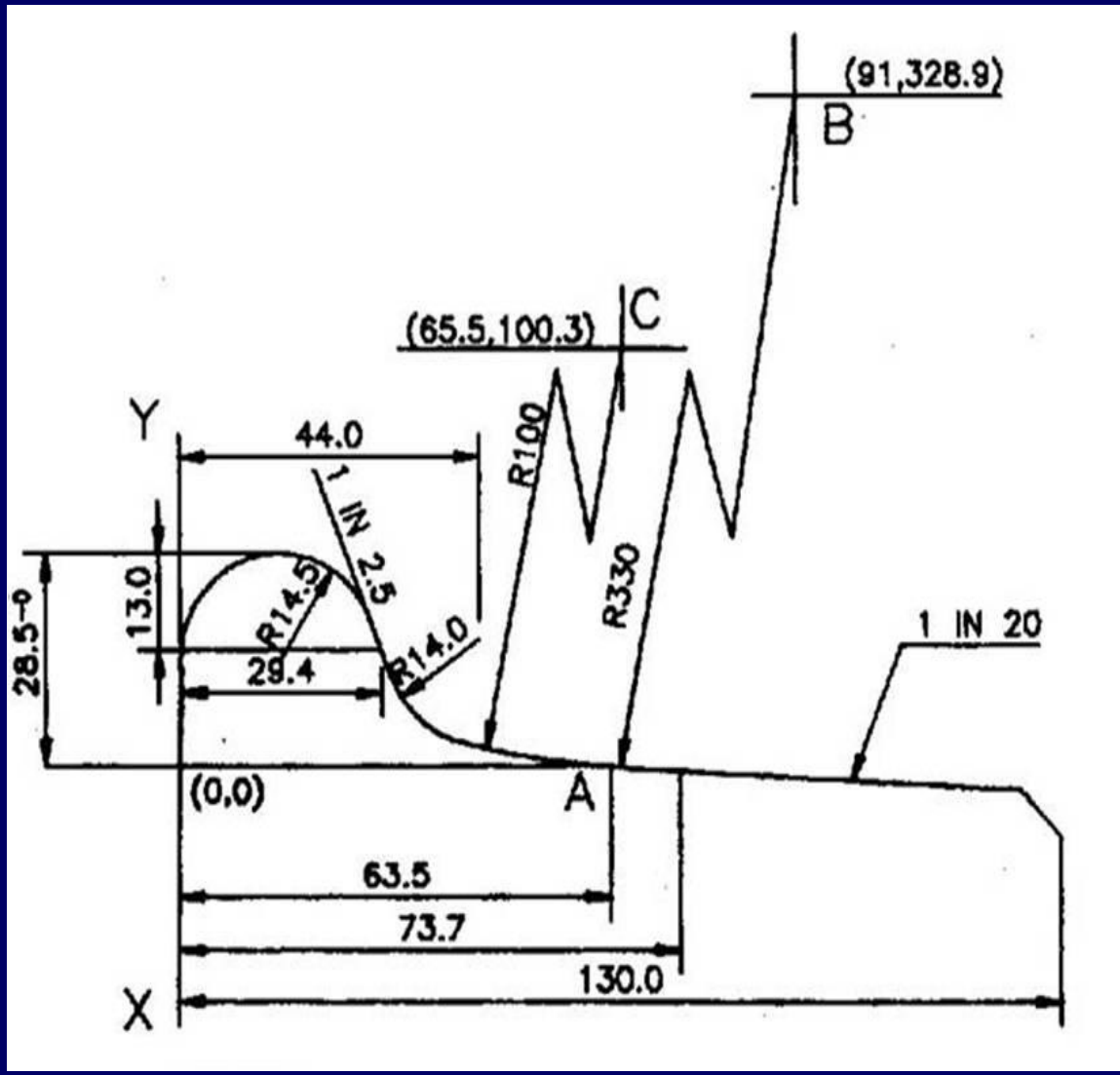


WHEEL DISTANCE GAUGE

FIGURE 10.6

Wheel Tyre Profile

- Standard wheel profile
- Worn wheel profile (Conforming profile)
- No Intermediate profile now.



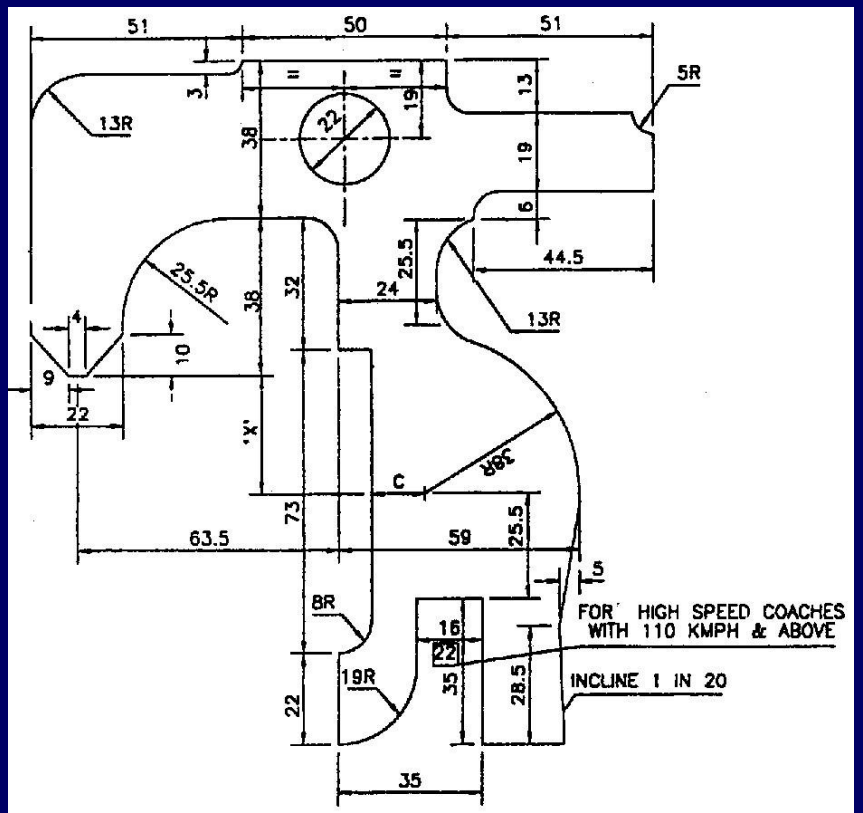
Difference in Wheel Diameter

	On the same axle	On the same trolley	On the same wagon
For Wagon	0.5	13	25
For Coach	0.5	5	13

- Prescribed in
  - Rule No. 2.8.14.2 IRCA Part III and
  - Rule No. 2.9.4 IRCA Part IV
- These limits do not form a part of train examination.
- The rejection of wheels worn beyond service limits will continue to be determined by the normal wear limits specified in IRCA Rules (Rly. Bd. letter No. 86/M(N)960/8 Dated 22.8.86).

Wheel Profile Defects

- Flat tyre
- Hollow tyre
- Sharp flange
- False flange
- Deep flange
- Thin flange
- Root radius



All coaches (Including EMU & DMU) 50 mm

NOTE:-

1. CONDEMNING MARK 'C' TO BE STAMPED ON BOTH SIDE OF GAUGE.
2. CONDEMNING MARKS FOR TYPE OF STOCK ON LINE ONLY NEEDS TO BE STAMPED.
3. DISTANCE 'X' AT WHICH CONDEMNING MARK 'C' FOR VARIOUS TYPE OF WHEELS TO BE STAMPED ARE AS BELOW:-

i) SOLID WHEEL OF ICF & BEML MAIN LINE COACHES	6.5 mm.
ii) SOLID WHEEL OF IRS MAIN LINE COACHES	5 mm.
iii) TYRED WHEEL OF IRS, ICF & BEML MAIN LINE COACHES	26 mm.
iv) TYRED WHEEL OF ac & dc EMU MOTOR COACHES.	38.5 mm.
v) TYRED WHEEL OF ac & dc EMU TRAILER COACHES.	28.5 mm.

SPECIAL FEATURES OF CASNUB BOGIE

CASNUB Bogie

- Main components
  - Side frames with friction plates
  - Bolster with wear liners
  - Friction shoe wedges
  - Centre pivot arrangement & Side Bearers
  - Load bearing springs and snubber springs
  - Spring plank
  - Adapter , Elastomeric Pad

Versions of CASNUB Bogie

- The various versions developed
  - CASNUB -22W (not in use)
  - CASNUB -22W(M)
  - CASNUB -22NL
  - CASNUB -22NLM
  - CASNUB -22NLB
  - CASNUB -22HS

CASNUB -22W

- Wide jaw category without elastomeric pad.
- No locking at Centre pivot and bolster pin.
- Clearance type side bearer with two rollers.
- The brake beam “pocket or sliding type”.
  - The brake head, integral part of the brake beam, slides in the pocket provided in the side frame.
- Maximum speed 75 KMPH , 22.9 T Axle load.

CASNUB 22W(M)

- EM pad introduced alongwith the adapter.
- Side frame with negative camber
  - For getting same buffer height while using EM pad.
- Spherical type centre pivot
  - fitted with bolster pin with castle nut and split pin.
- Constant contact type side bearer
  - metal bonded housed in modified housing.
- Hanger type Brake beam introduced
  - Discontinued in the later versions of the bogie.

CASNUB -22NL

- The side bearer, centre pivot, bolster
  - similar to 22W(M) version.
- “Narrow jaw” category introduced.
  - Therefore the adapter used of smaller size.
- Side frame modified to accommodate
  - sliding type b/beam hanger similar to 22W version
- Centre pivot pin is locked by shackle lock.

CASNUB 22NLB

- Similar to 22NL version, except for bolster.
- The shape of the bolster is “fish belly” at the centre to reduce the weight of bogie.
- However only a marginal weight reduction compared to NL type has been possible.

CASNUB 22NLM

- Similar to NLB version in relation to dimension.
- Material of the side frame and bolster is changed.
  - Resulted in reduction of the bogie weight.
- The weight of the NLM version bogie is 5.125T where as the weight of NL version is 5.5T.

CASNUB 22HS

- Developed for operation at speed 100 Kmph.
- Almost same as NLB type except
  - Outer gib opening increased to 241 from 234 mm.
  - higher diameter spigot for the spring seat.
- The side bearer used was spring loaded type.
  - Now PU type used.

Spring Nest

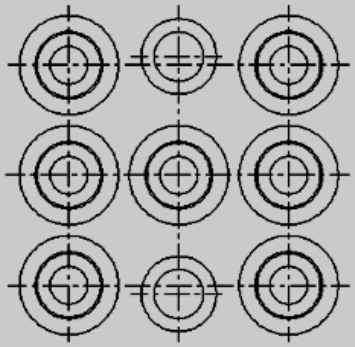
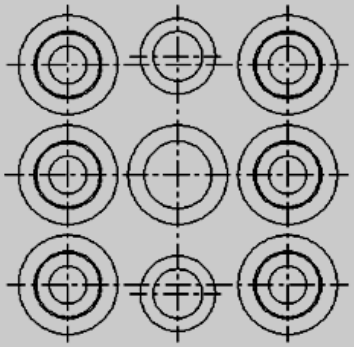
Type	Outer	Inner	Snubber
20.3 T non HS	6	4	2
20.3 T HS	7	6	2
22.9 T	7	5	2

Springs Arrangement

WX05100B.

ANNEXURE– IIA

SPRING GROUPS FOR VARIOUS AXLE LOADS

AXLE LOAD		22.9 TONNES			20.32 TONNES		
SPRING GROUP FOR EACH END OF BOGIE BOLSTER							
NUMBER OF SPRINGS PER GROUP		OUTER (7)	INNER (7)	SNUBBER (2)	OUTER (7)	INNER (6)	SNUBBER (2)
TEST LOAD ON BOGIE PIVOT & HEIGHT OF C.P TOP FROM R.L	CONDITION	LOAD (t)	HEIGHT (mm)		LOAD (t)	HEIGHT (mm)	
	TARE	6.066	932^{+3}_{-8}		6.066	932^{+3}_{-8}	
	GROSS	40.38	892^{+3}_{-8}		35.22	895^{+3}_{-8}	
	50% OVER LOAD	60.57	870.5^{+3}_{-8}		52.83	874.5^{+3}_{-8}	
DETAILS OF SPRINGS		WD–92058–S/5, OUTER ITEM–1, INNER ITEM–2, SNUBBER ITEM–3					

FIAT BOGIE

SPECIAL FEATURES OF FIAT BOGIE

Main Feature of FIAT Bogie

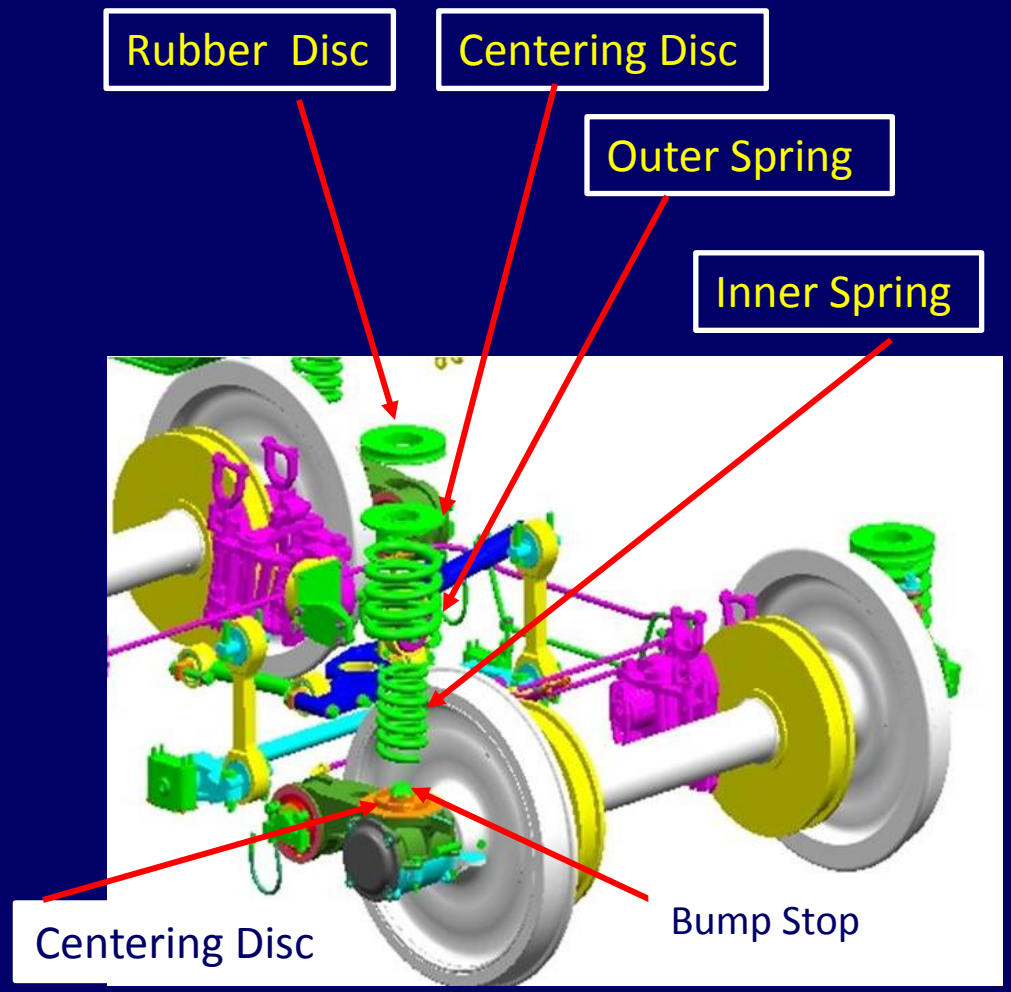
- An adoption of EUROFIMA design
  - manufactured by FIAT/SIG Switzerland.
- Maximum operating speed is 160 kmph
  - Up to 200 kmph with minor modification.
- Permanent earthing connection
  - To safeguard axle bearings.
- Excellent ride index, superior ride quality.

Comparison of FIAT with ICF Bogie

Features	FIAT	ICF
Speed Potential (kmph)	160	140
Ride Index (max.)	2.75 at 180kmph	3.5 at 140kmph
Weight (t)	6.5	5.72 (13t) 6.5(16.25t)
Wheel base(mm)	2560	2896
Inner axle distance (m)	12.34	11.89
Wheel dia new (mm)	915	915
Wheel dia worn (mm)	845	**825**
Axle box guidance	Articulated	Rigid
Dampers – Primary	Hydraulic damper	Dashpot

Primary Suspension (FIAT Bogie)

- Nested steel coil springs.
- Control arm axle guidance.
- Lateral flexibility- reduced wheel root wear.
- Bump stop (rubber spring) over steel spring.
- Hydraulic dampers.



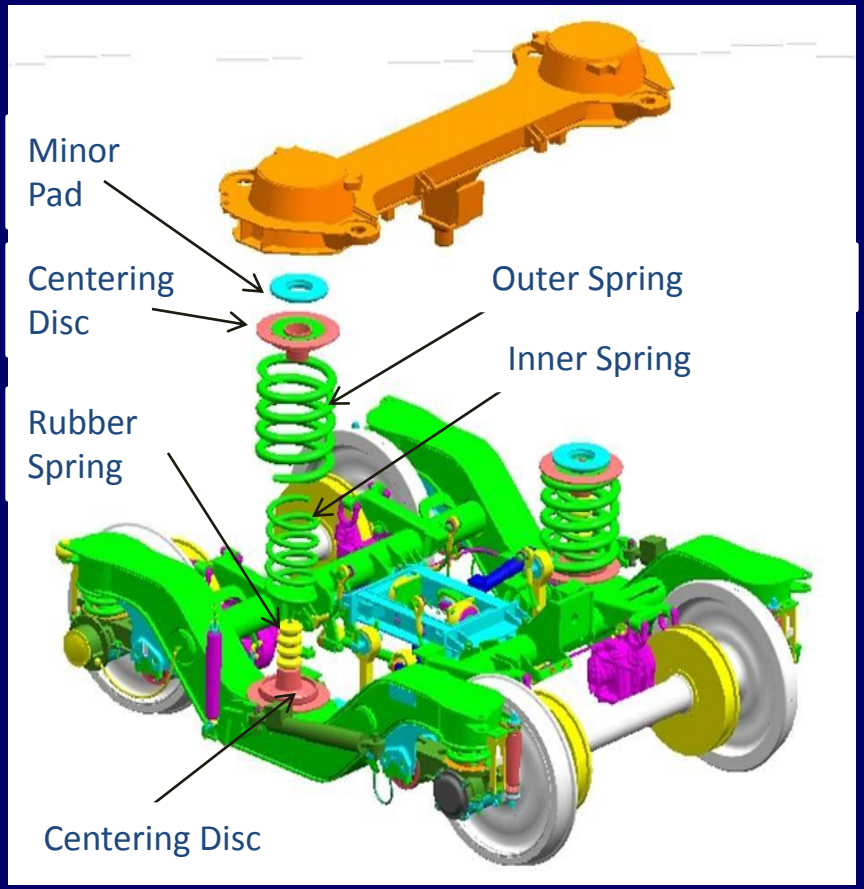
Primary Suspension Bump Stop

Upper part of bump stop at bogie frame ends

Lower centering disc with bump stop at Axle Box

Secondary Suspension (FIAT Bogie)

- Consists of
  - Nested flexi-coil steel spring.
  - Minor pads
    - Helps the two bogies to align equally.
  - Rubber spring
    - Inside coil springs for progressive characteristic.

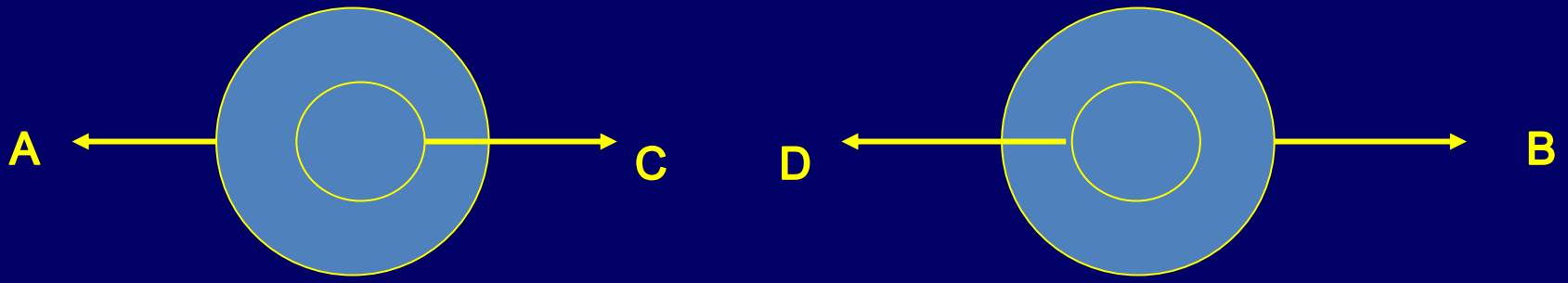


Marking on Springs

- Al. Tape – Indicates positive direction of the alignment deviation
- Copper Band – Gives length of the spring under test load and the value of the alignment deviation
- Stamping on flat portion – Gives month & year of manufacture and running serial number.

Paring of Secondary Springs

- The difference between alignment deviations
  - Outer springs 4mm max
  - Inner springs 8mm max.
- Coupling such as
  - Greater outer with greater inner and vice versa.
    - If A greater than B, C should be greater than D
    - A - B = 4 mm max, C - D = 8 mm max



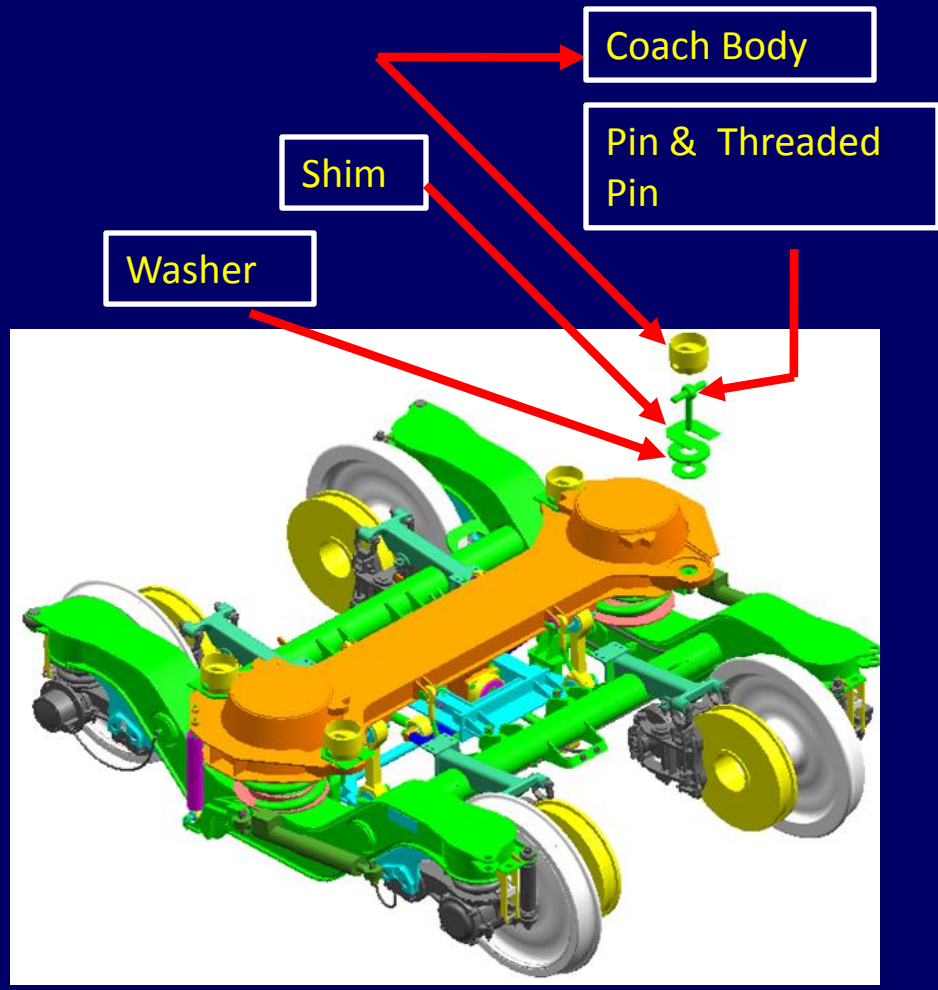
Secondary Suspension Components

Minor pad

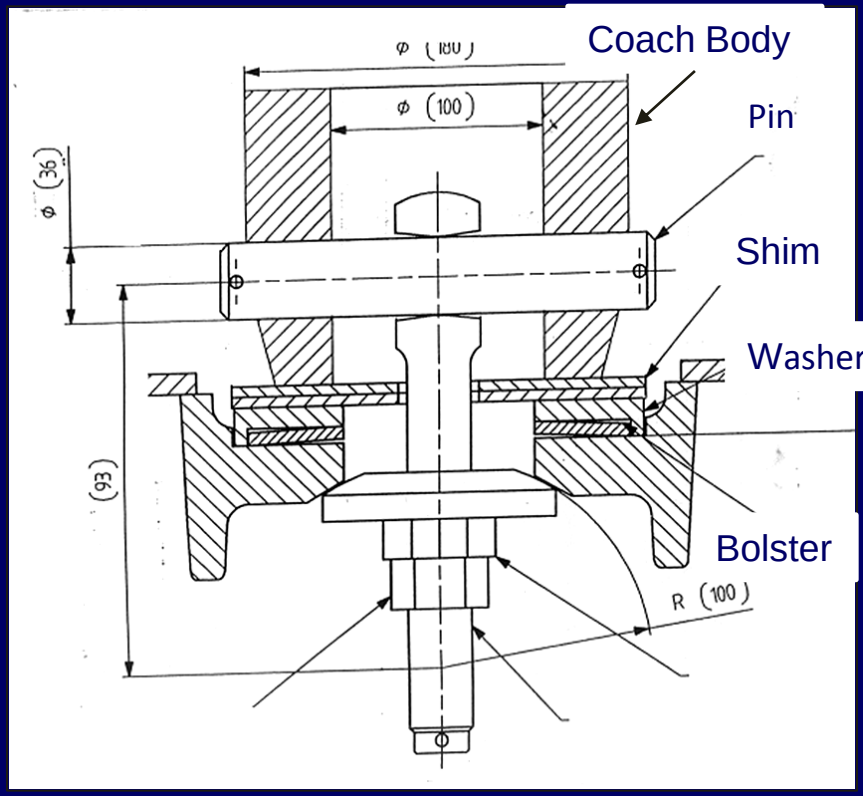
Upper centering disc with rubber spring

Body-Bogie Bolster Joint (FIAT Bogie)

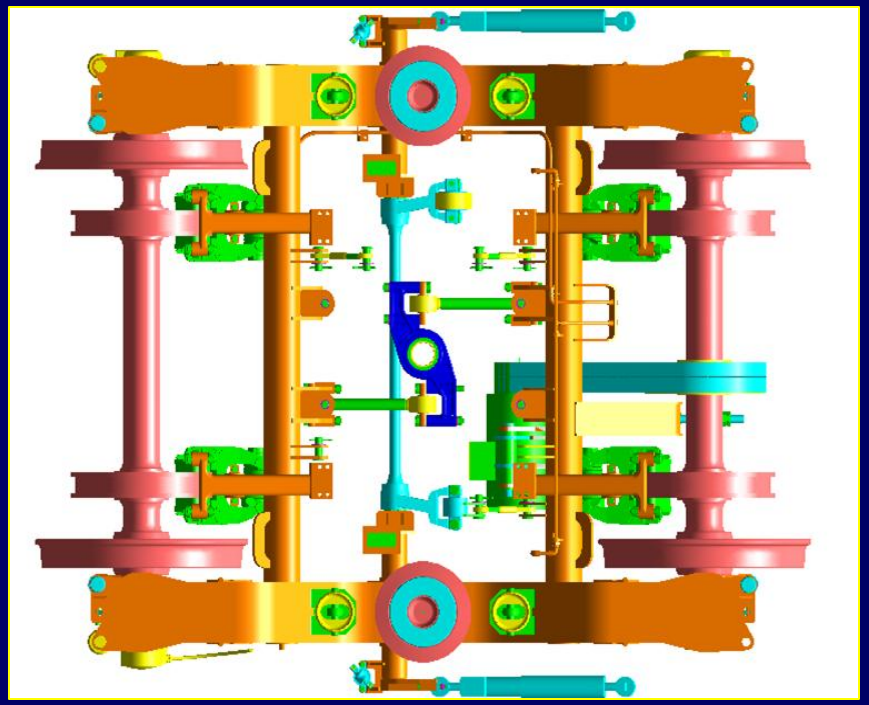
- Rigid type connection.
- Consists of disc spring.
- Easy buffer height adjustment.

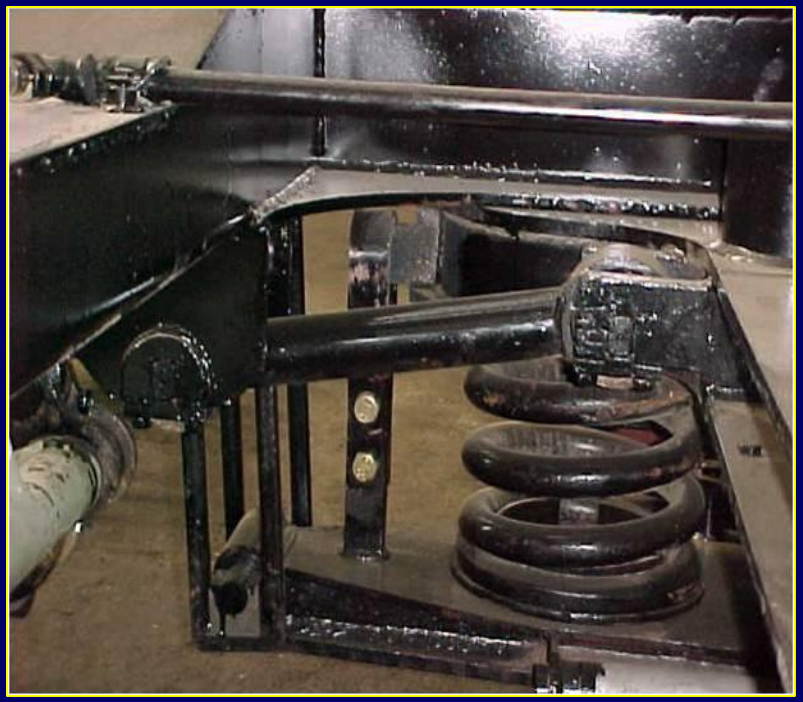


Buffer Height Adjustment (FIAT Bogie)



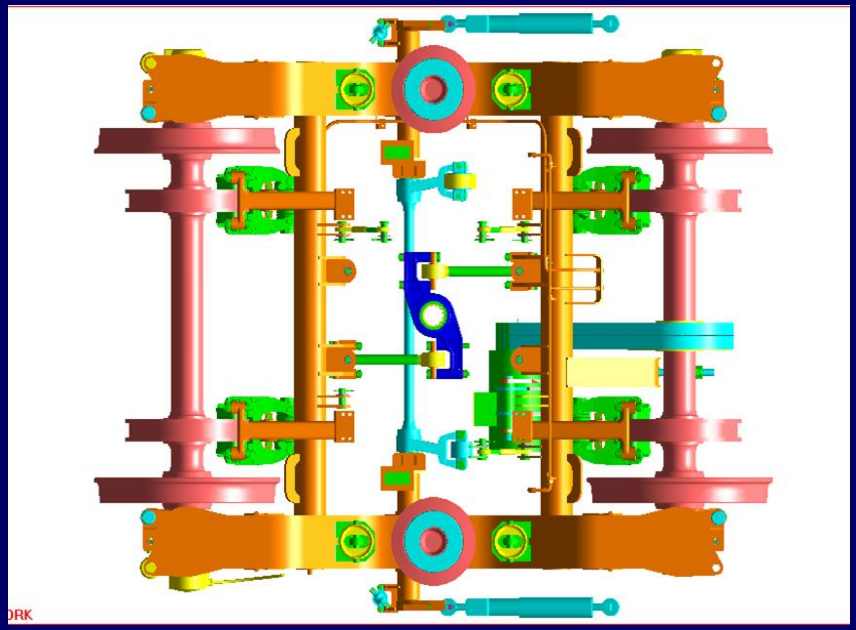
Traction Unit FIAT vs ICF



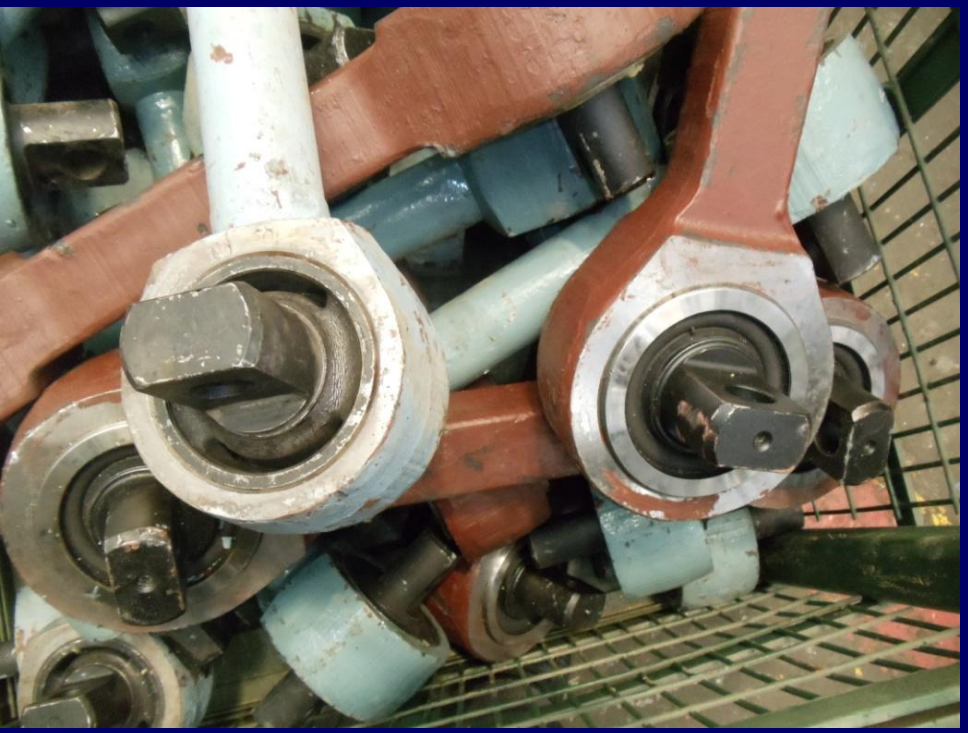


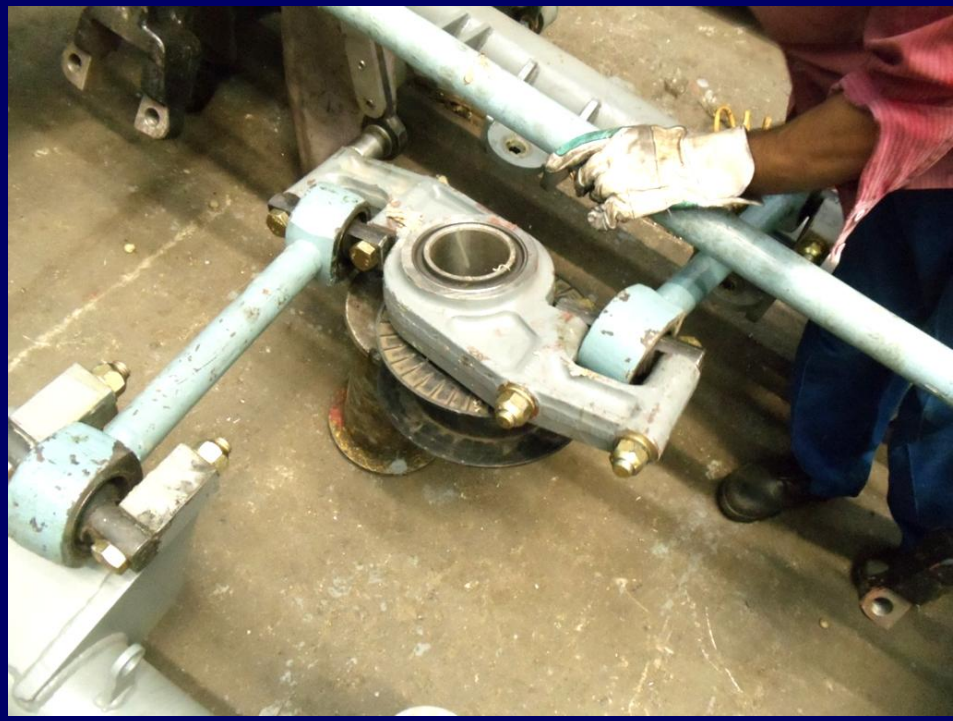
Traction Centre (FIAT Bogie)

- Transmits traction and braking forces between body and bogie frame.
  - Two traction rods
  - One traction lever on the bolster pin.



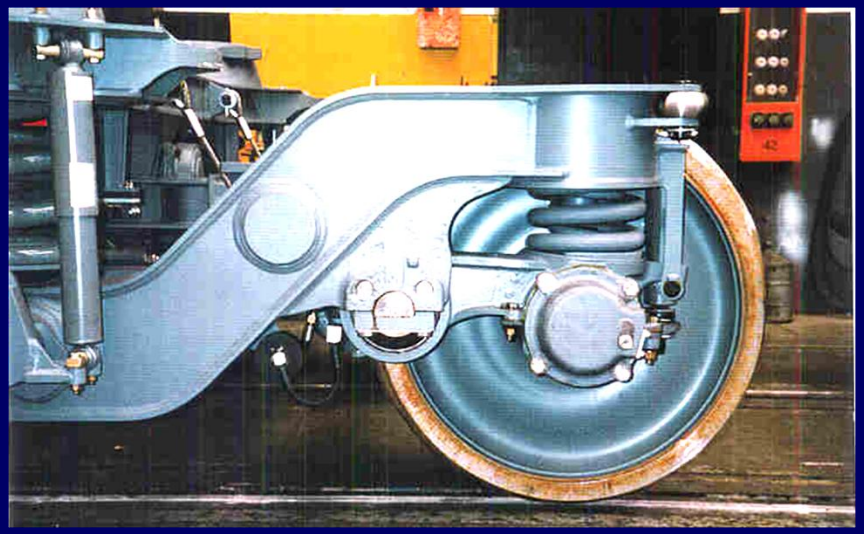
Bush of Traction Rod and Rod Link



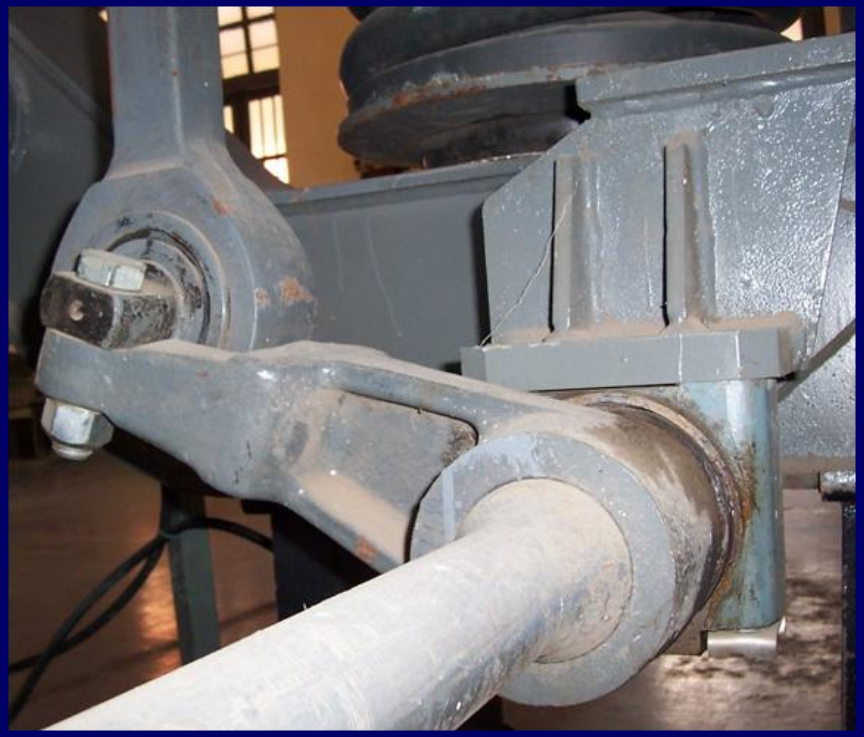


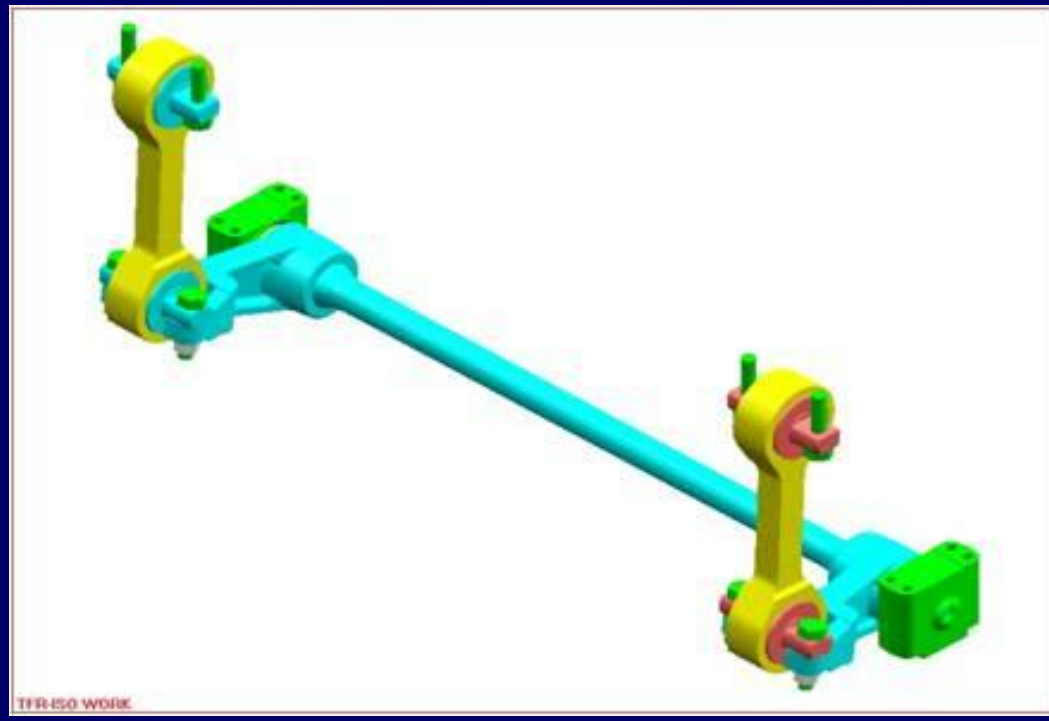
Control Arm Assembly (FIAT Bogie)

- By articulated control arm system.
- Also utilized to transmit
  - Traction and braking forces between bogie frame and axle assembly.



Anti Roll Bar Mechanism (FIAT Bogie)

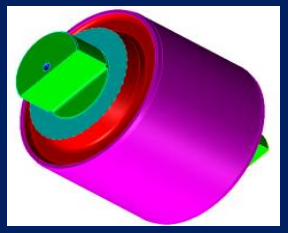
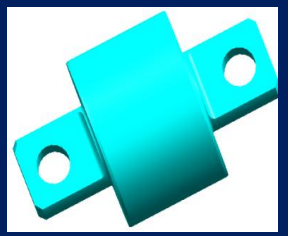
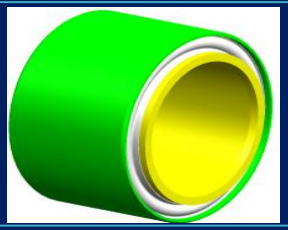
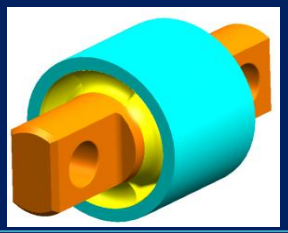




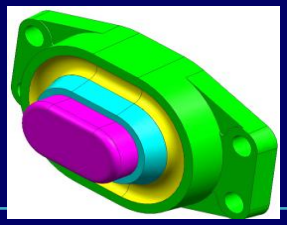
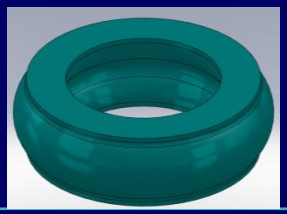
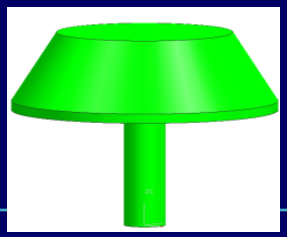
Wheel Balancing

- For speed ≥130 Kmph.
- RCF's spec.no. MDTS-168
- 320 rpm is maintained.
- Unbalanced moment on wheel is balanced by glueing the needed weights.

Imported Items (Rubber Joints)

Description	Drg.No.	Photo	QPC
Axle Box Pivot Bush	1247488001		08
Ball joint roll link	C53 973 REB BRED 8416		08
Traction center Elastic joint	C53 973 REF BRED 8397 rev 02		02
Ball joint traction lever	C53 973 REF BRED 8403 rev 02		08

Imported Other Rubber Items

Description	Drg.No.	Photo	QPC
Lateral Bump Stop	C53 973REB BRED 8374 rev. 02		04
Rubber Spring	1268685 Ver '01'		04
Miner Pad	1903149 alt 'a'		08
Primary Vertical Bump Stop	1227081		08

Imported Primary Springs (T.S.17.248 100 05)

Coach Type	Descr	Drg. No.	QPC
AC- CCar (Ist & 2nd), Hot buffet, AC-2T/ EOG, FAC/EOG	Outer	1 267 411	8
	Inner	1 267 412	8
Gen-Van	Outer	1 277 142	8
	Inner	1 277 143	8
AC-3T EOG	Outer	1 267 411	8
	Inner	1 277 143	8

Sources:	i) M/s Grueber, Germany ii) M/s LANGEN and SONDERMANN GMBH, Germany

Imported Secondary Springs (T.S.17.248 100 05)

Coach Type	Description	Drg. No.	Qty Per Coach
AC- CCar (Ist & 2nd), Hot buffet, AC-2T/ EOG, FAC/EOG	Outer	1 269 514	4
	Inner	1 269 513	4
Gen-Van Gen side	Outer	1 277 146	2
	Inner	1 277 145	2
Gen-Van Lug. Comptt. side	Outer	1 268 836	2
	Inner	1 268 837	2
AC-3T EOG	Outer	1 268 836	4
	Inner	1 269 513	4

Imported Dampers

Description	Drg. No.	QPC (nos.)
Primary Vertical	LW05102	8
Secondary Vertical	LW05101	4
Secondary lateral	LW05100	2
Lateral damper for Air spring bogie	LW 05122	2
Yaw	LW05103	4

Imported Wheel Disc & Brake Disc

Description	Photo	QPC
Wheel Disc		08
Brake Disc KB's drg no. 1B83756/1		08

Periodicity of Maintenance Schedules

S N	Schedule	Periodicity
1.	Trip Sch. D1	7 days± 1 day
2.	Monthly Sch./D2	30 days ± 3 days
3.	Six Monthly Sch./D3	180 days ± 15 days
4.	Shop Sch. I/ IOH	18 Month /6 Lakhs Kms earned whichever is earlier
5.	Shop Sch. II/ POH	3 Years/12 Lakhs Kms earned whichever is earlier
6.	Shop Sch. III/ POH	6Years/24 Lakhs Kms earned whichever is earlier

NAME AND FUNCTION OF BRAKING SYSTEM COMPONENT

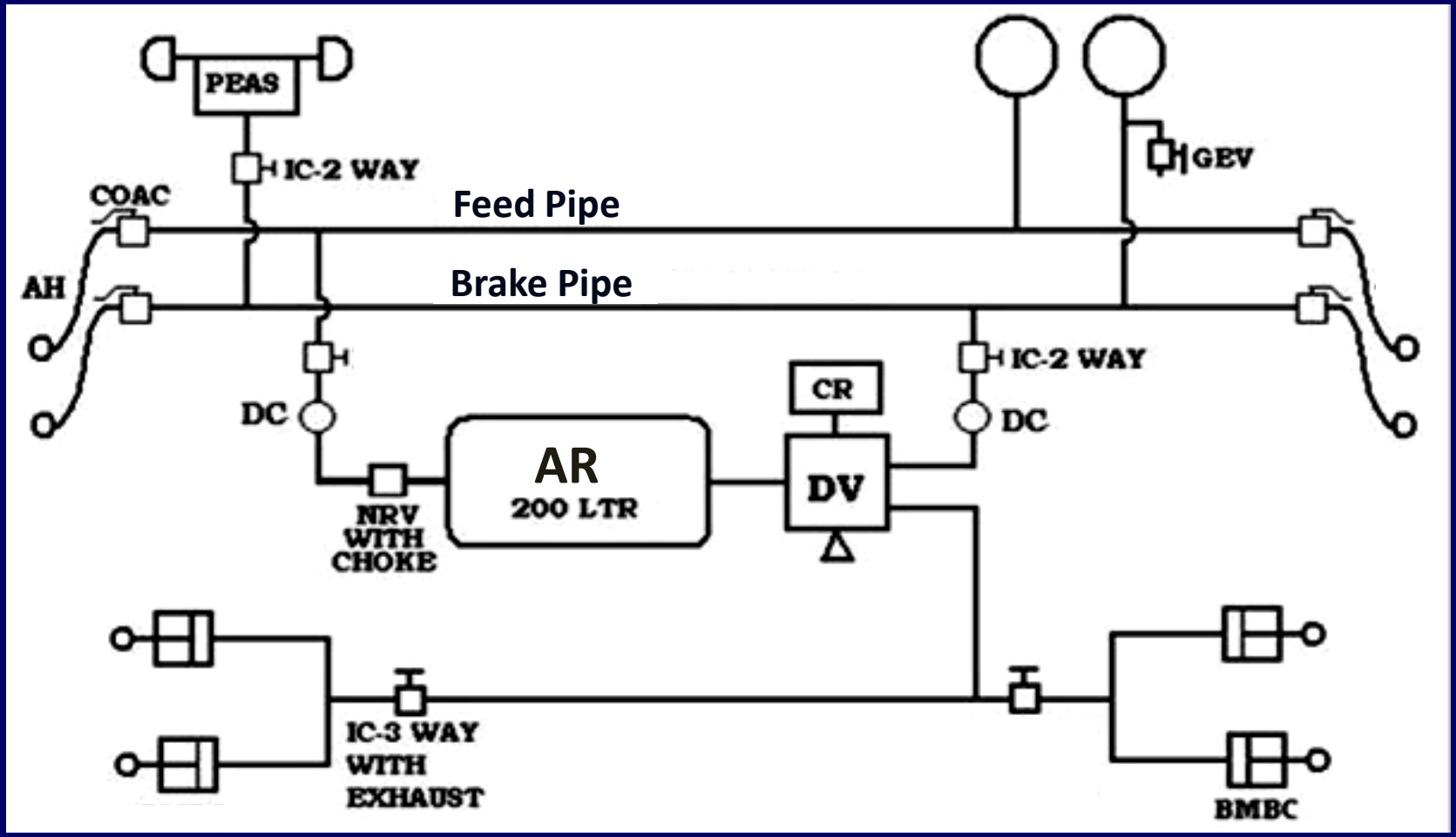
Interplay between Braking & Load Transfer

- Primary Suspension short-circuiting
- Emergency braking issues
- Shuttling (longitudinal) effect
- Weight Transfer

Basic Requirements from Brake System

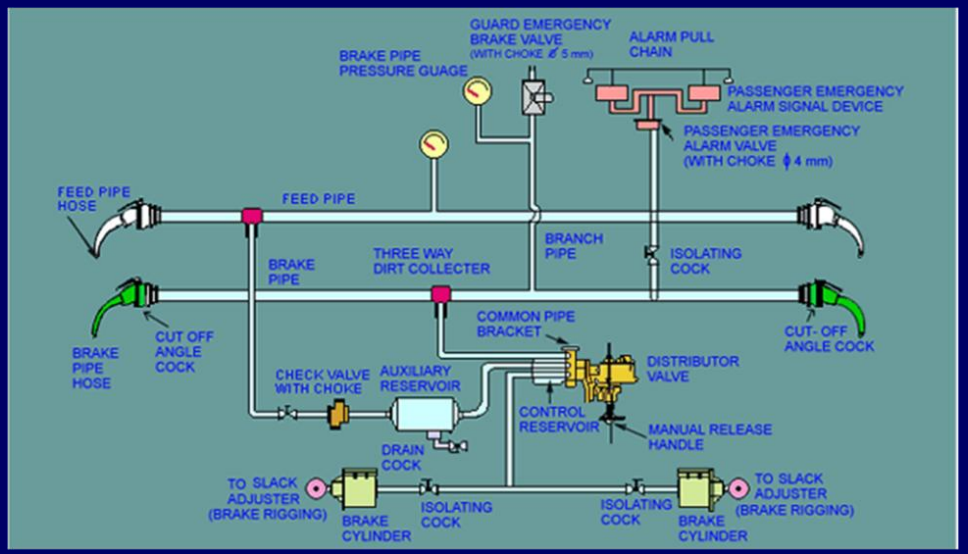
- Controlled braking
  - Braking control to loco pilots and guard.
  - Passenger communication system in coach.
- EBD (Emergency Braking Distance) within limit.
- Fail safe i.e. automatic braking when train parts.
- Brake inexhaustibility.
- Less fading of brake power during long run.
- Easy maintainability.
- Reliability
- Multiple operation

Schematic Diagram (ICF with BMBC)



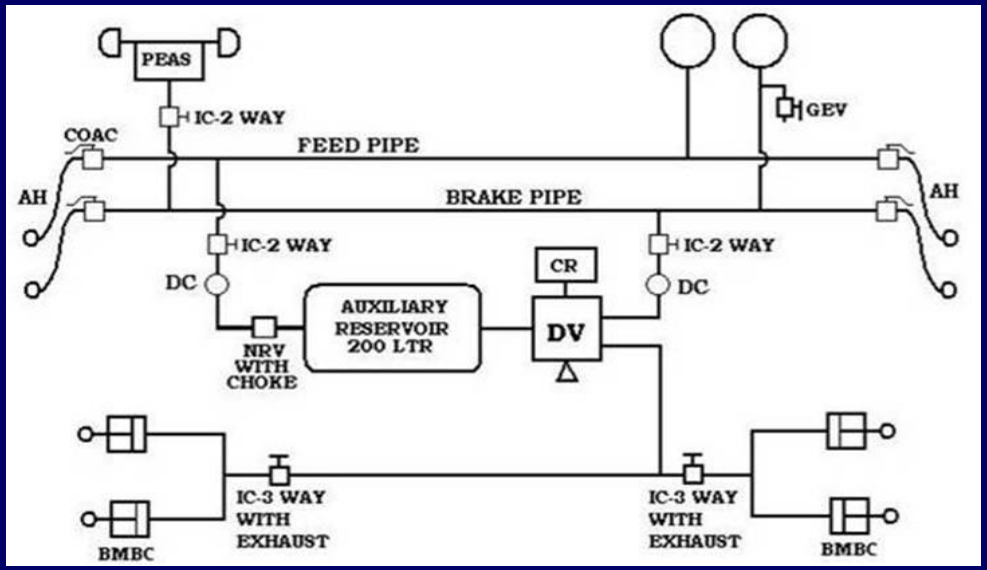
Major Components

- Common pipe bracket (CPB)
- Distributor valve (DV)
- Control reservoir (CR)
- Auxiliary reservoir (AR)
- Brake cylinder (BC)
- Brake pipe & feed pipe



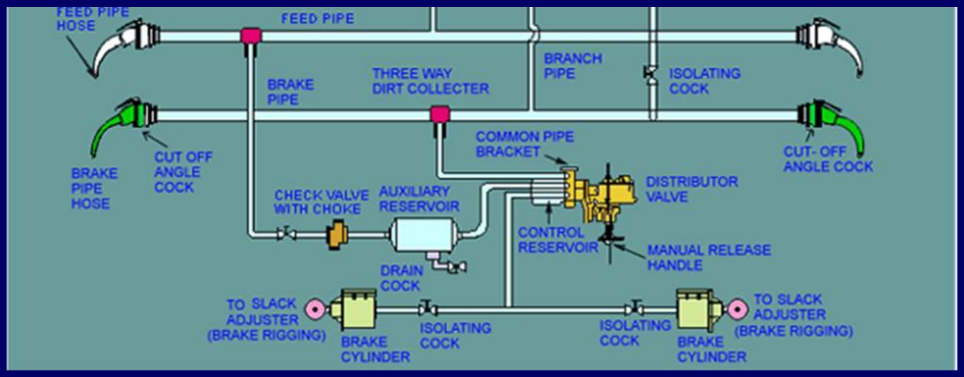
Major Components

- Air hose with palm end coupling
- Cut off angle cock
- Dirt collector
- Isolating cock (2-way and 3-way)
- Check valve with choke
- Brake riggings

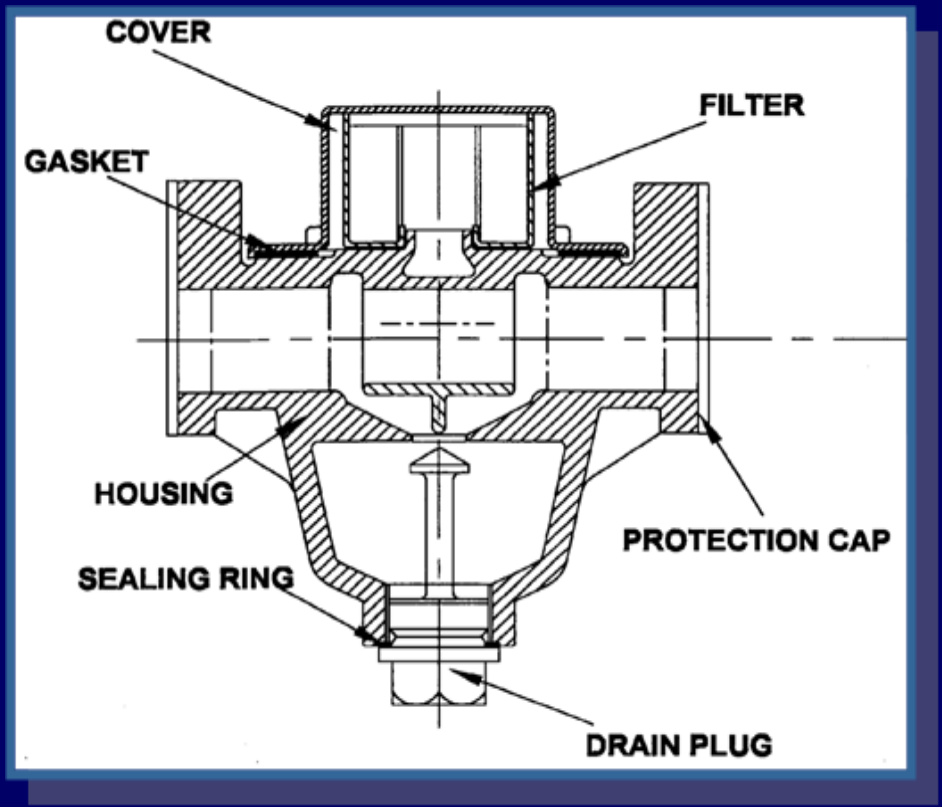


Common Pipe Bracket (CPB)

- Mounted on the underframe of a vehicle.
- Facilitates fitment of any make of DV.
- The DV along with the intermediate piece (sandwich) and the CR mounted on it's two opposite faces.
- Facilitates easy removal of DV without disturbing the pipe connections.



Dirt collector



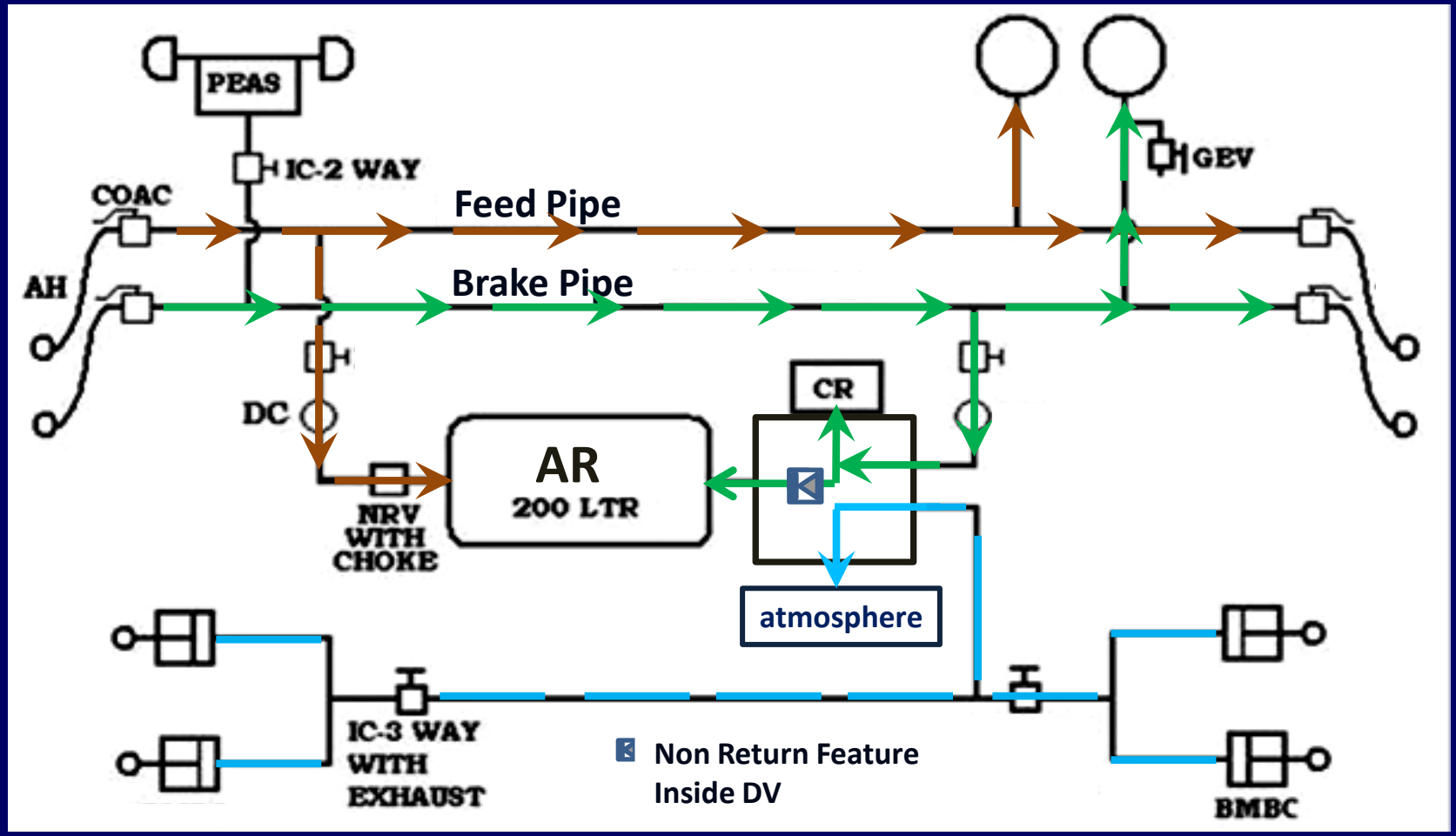
- Placed in BP and FP line.
- A trap & store house for the dust and dirt.
- The air strikes against the wall of centrifugal housing.
- Dust, dirt and scales etc. entrapped and collected in the dirt chamber

WORKING STAGES OF AIR BRAKE SYSTEM

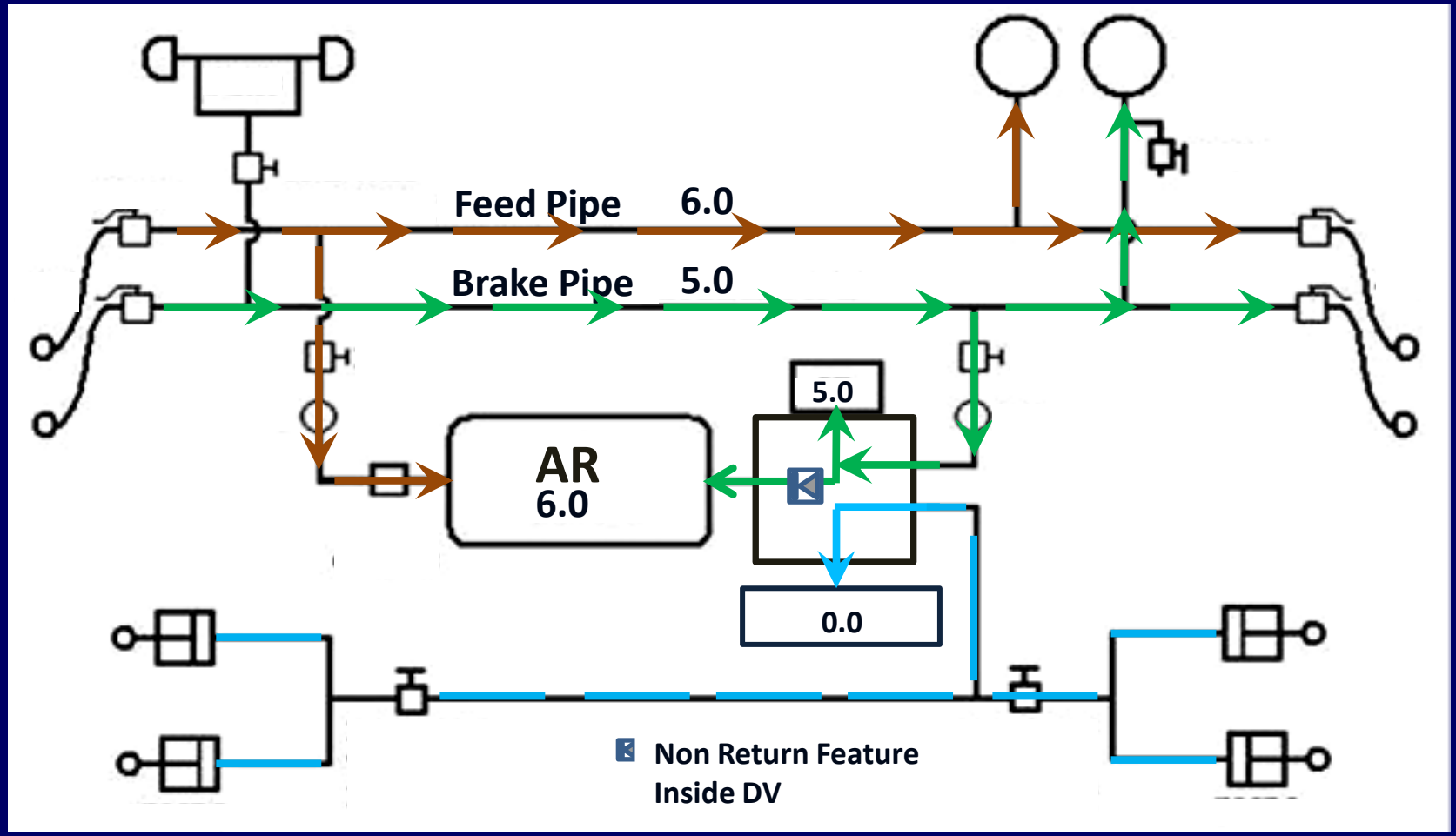
Three Working Stages

- Charging stage
  - Brake pipe(BP) charged with 5 Kg/cm^2 air pressure.
- Application stage
  - BP pressure dropped for brake application.
- Releasing stage
  - BP pressure again raised for brake release.

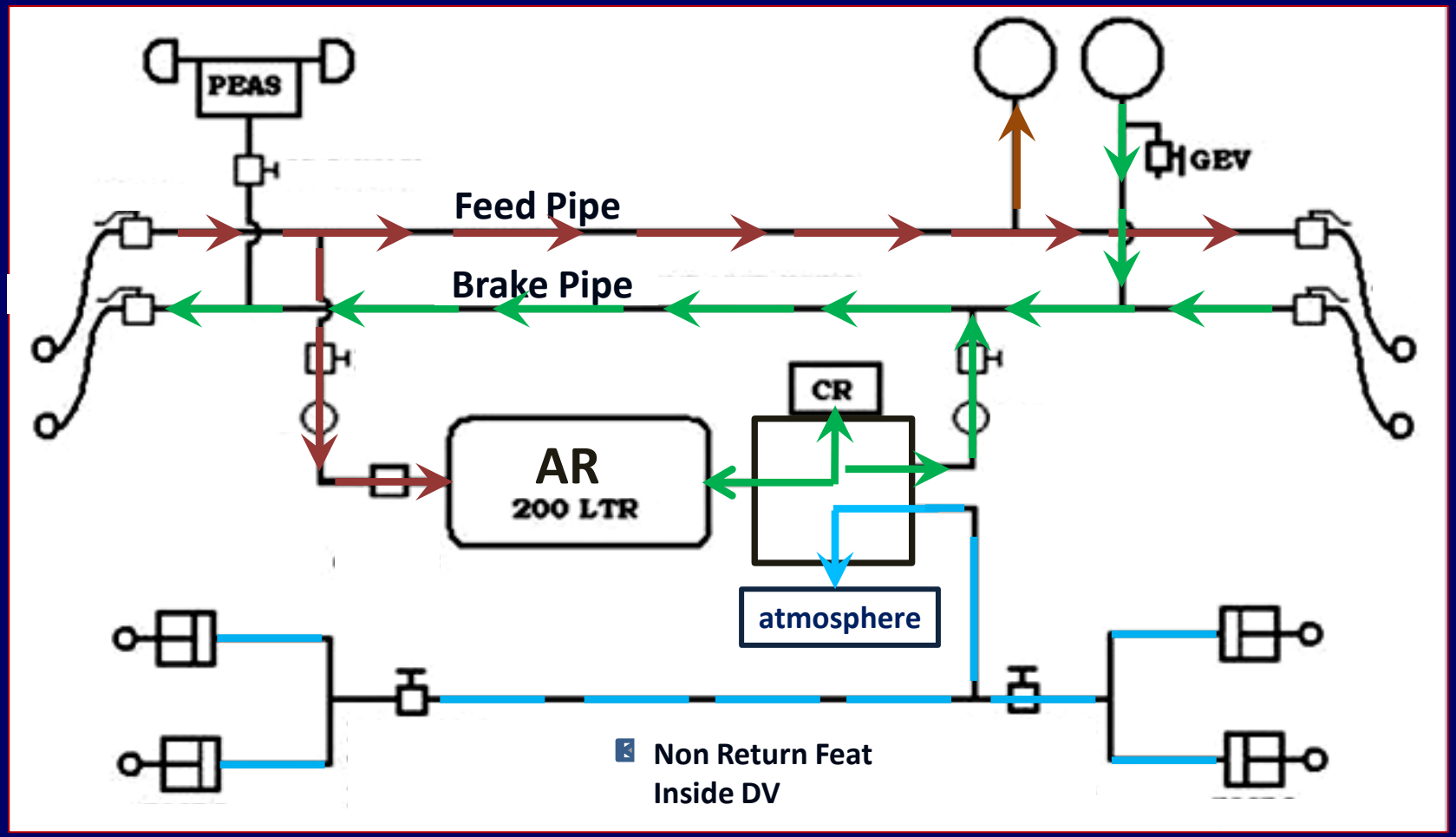
Air Flow: Charging Stage



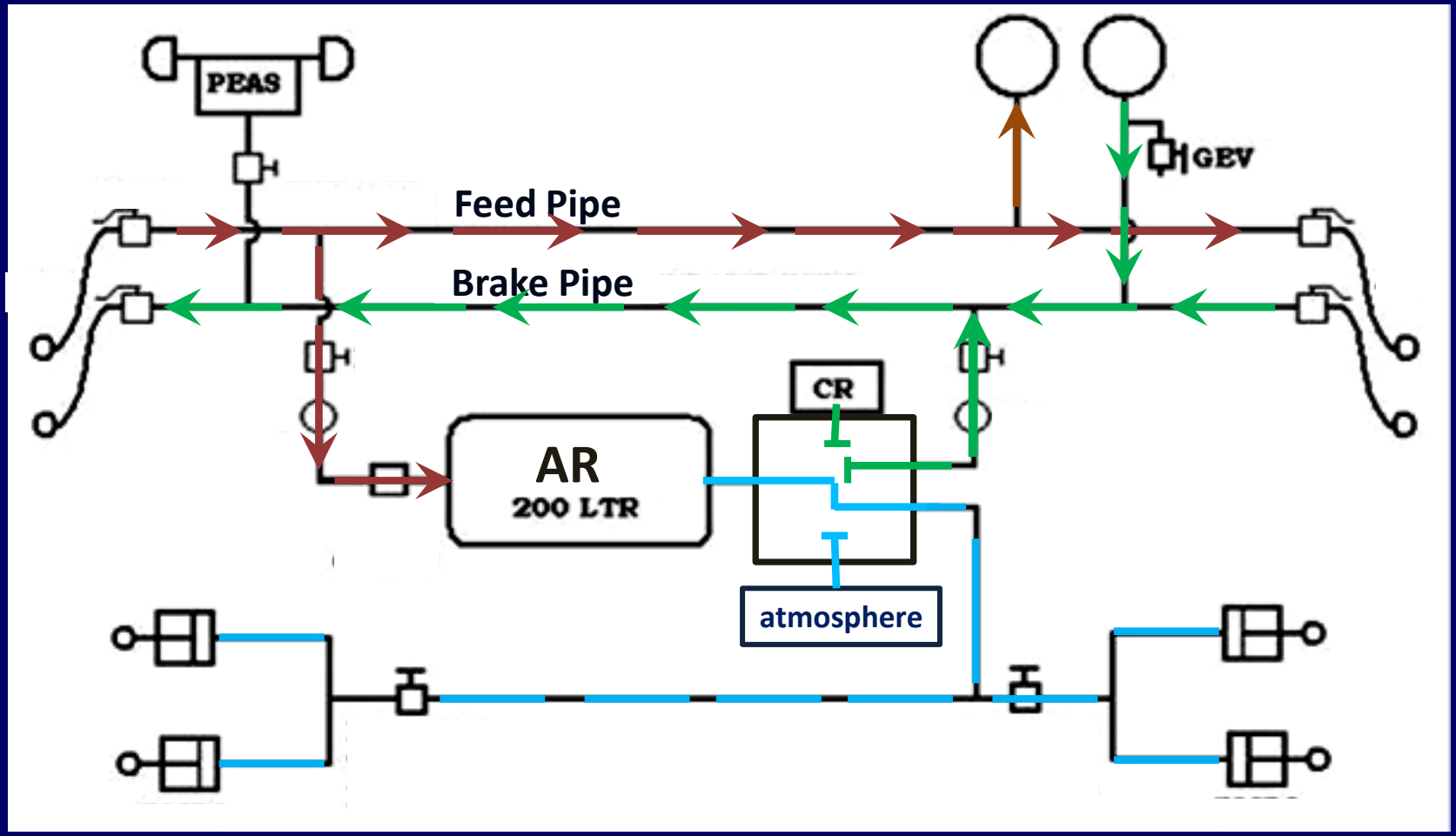
Pressures: Charging Stage



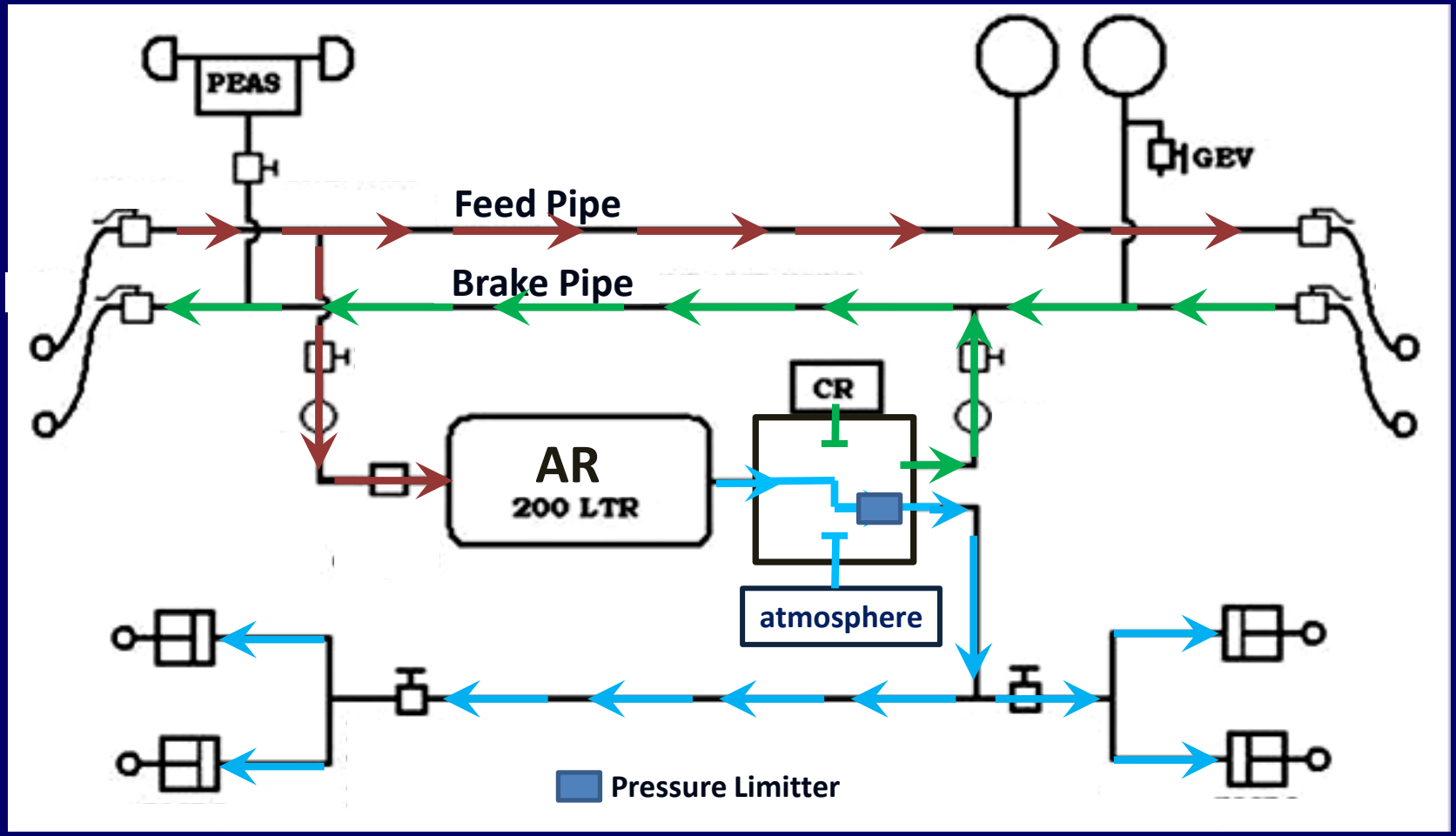
Air Flow: Application Stage



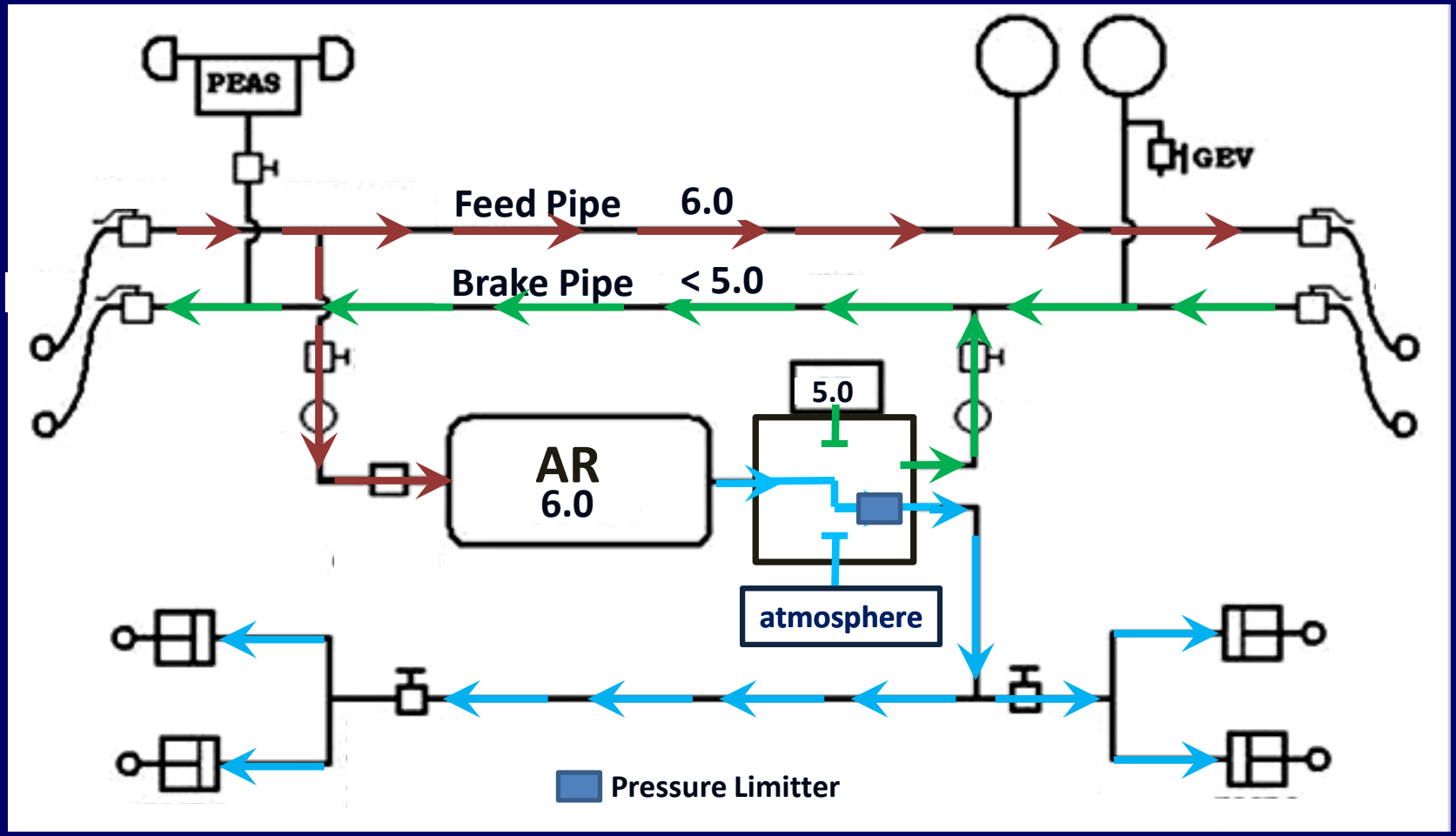
Air Flow: Application Stage



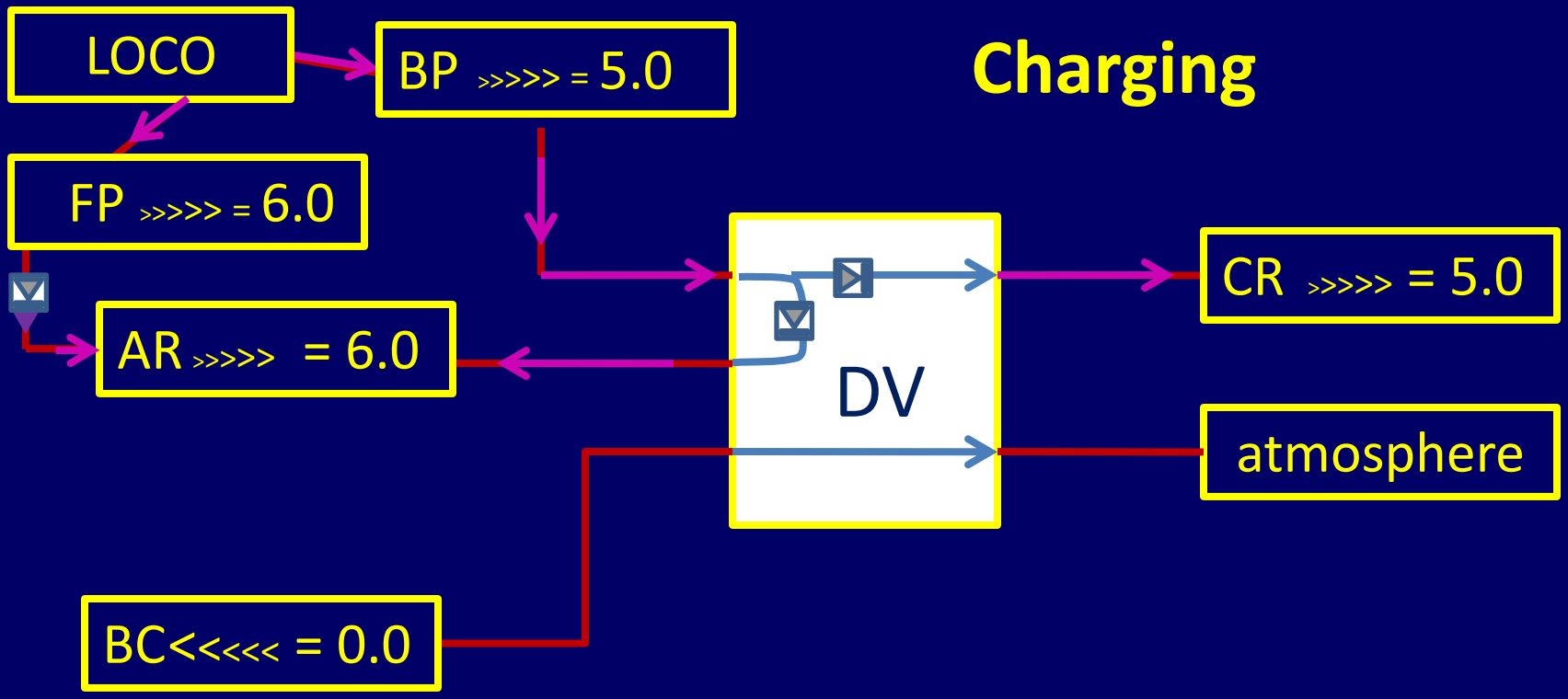
Air Flow: Application Stage



Pressures: Application Stage

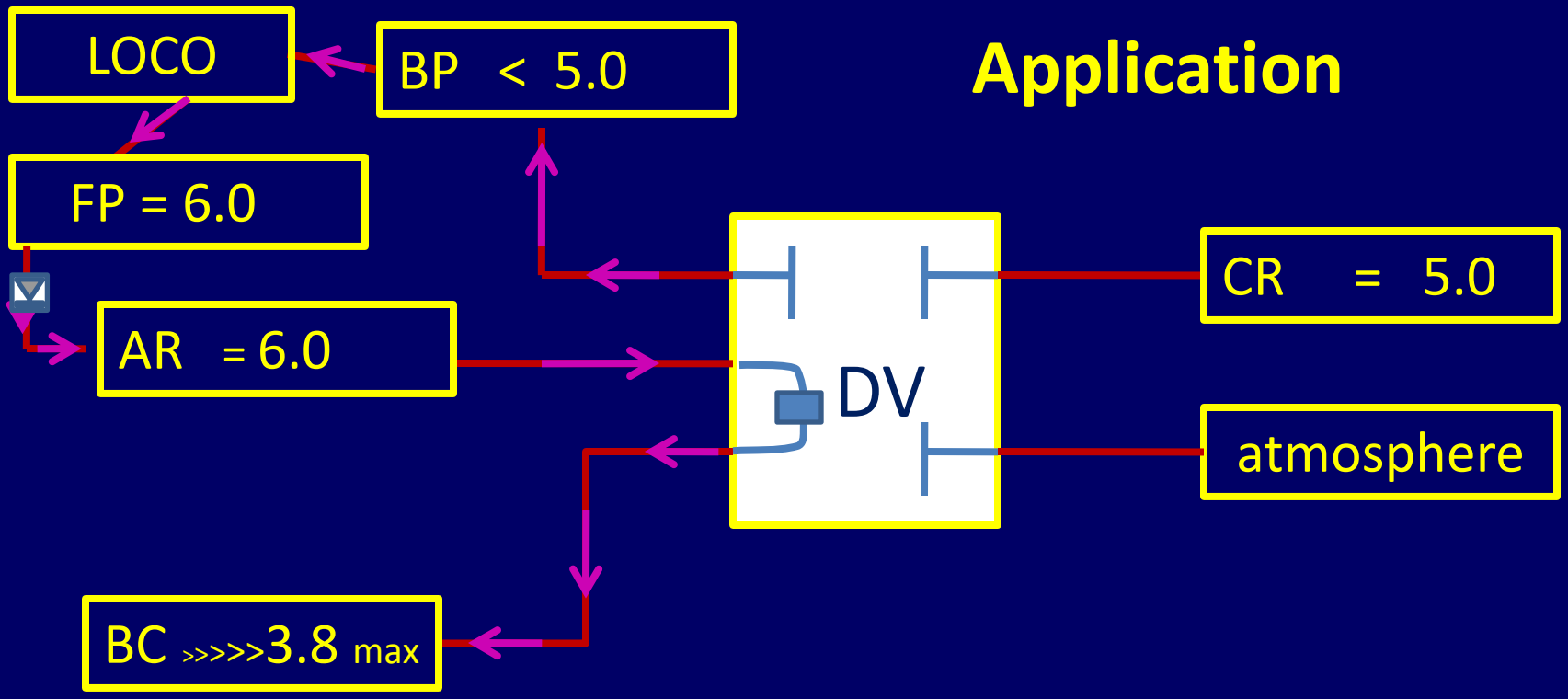


Pressure Level: Charging Stage



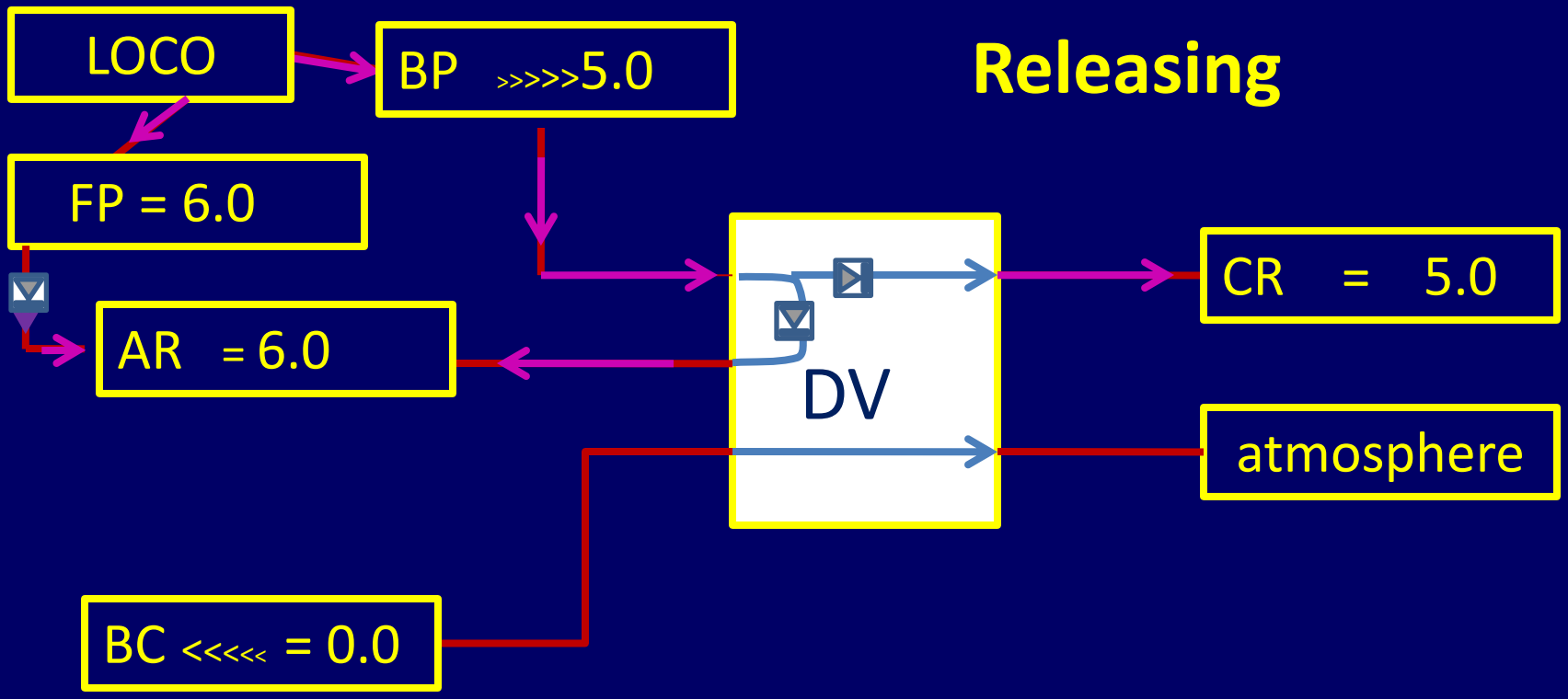
- Charging Stage: BP is charged at 5 Kg/cm^2.

Pressure Level: Application Stage



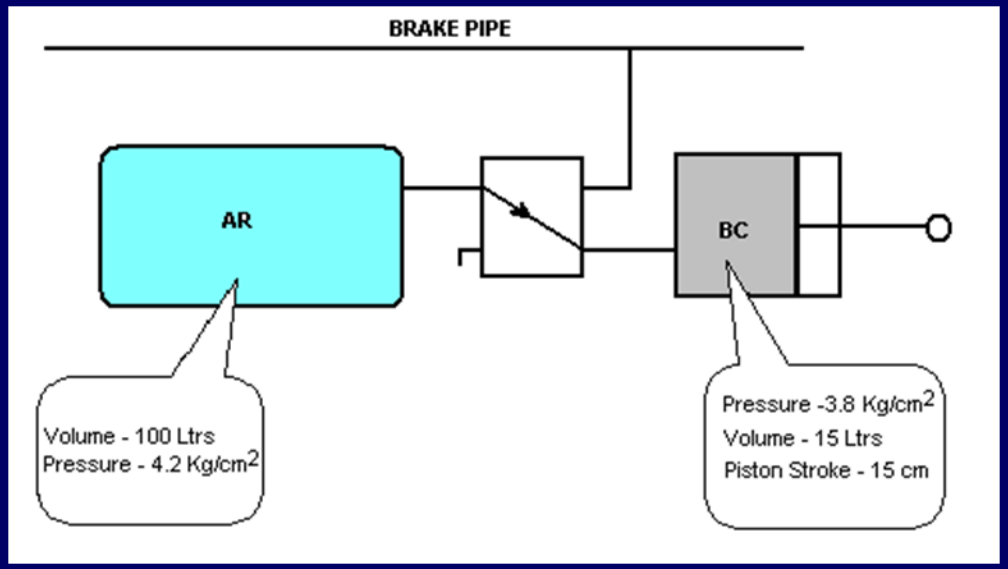
- Application Stage: BP pressure is reduced.

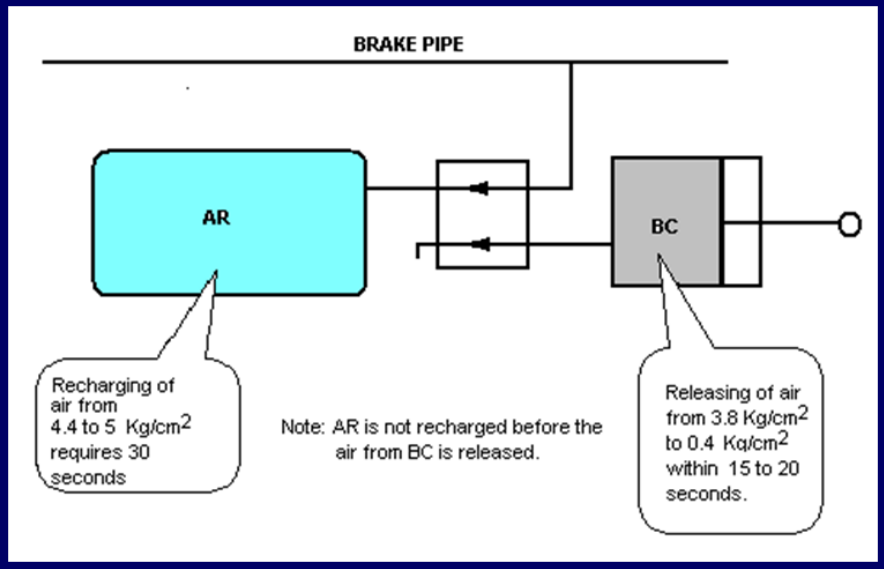
Pressure Level: Releasing Stage



- Releasing Stage: BP pressure is again raised.

Single Pipe vs Twin Pipe System





Modes of Brake Application

Description	Reduction in B. P. Pressure
Minimum Brake Application	0.5 to 0.8Kg/cm^2
Service Brake Application	0.8 to 1.0Kg/cm^2
Full Service Brake Application	1.0 to 1.5Kg/cm^2
Emergency Brake Application	Brake pipe pressure fully exhausted

MAJOR BRAKE COMPONENTS AND THEIR FUNCTIONS

DISTRIBUTOR VALVE

Types of DV

- Three designs of DV's are in use on IR:
  - KE type.
  - C3W Type.
  - P4aG type.

A decision has already been taken that new stocks manufactured henceforth will only be fitted either with C3W or KE type DV.

Function of DV

- Charges the system to regime pressure:
  - During normal/running condition.
- Helps in all types of brake application:
  - Graduated, full service as well as emergency type.
- Helps in brake release:
  - Graduated as well as manual.
- Controls the brake application & release time:
  - As per service conditions.
- Limits max. designed BC pressure.

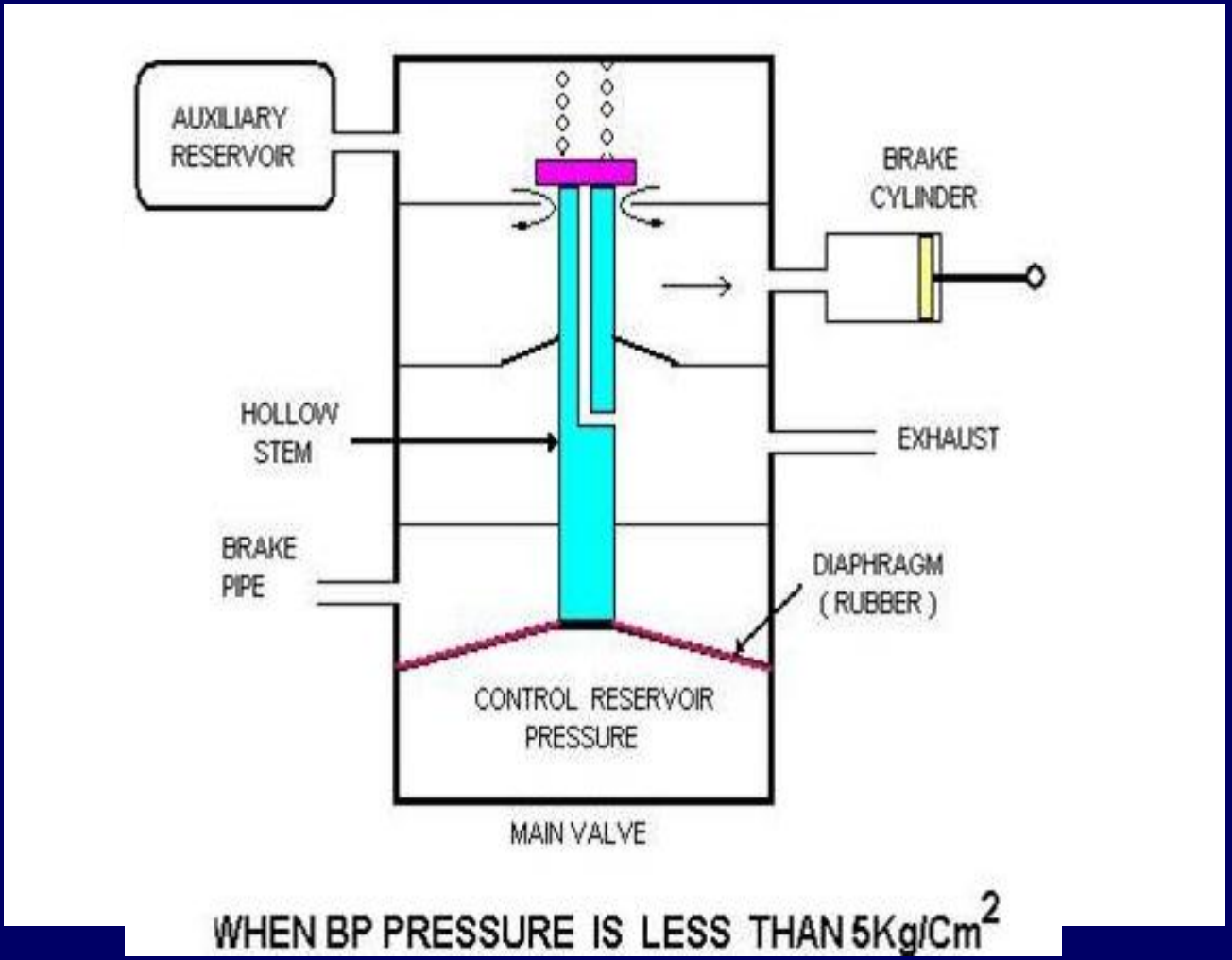
Function of DV

- Accelerates propagation of initial reduction of BP pressure throughout the length of the train
  - By arranging local vent of BP pressure inside the DV till BC pressure maintained at 0.8 Kg/cm^2.
- Protects overcharging of CR up to some extent
  - When the BP is overcharged after full service application for quick brake release.
- Facilitates to isolate the system if required, and
- Complete system can be evacuated manually.

KE type DV

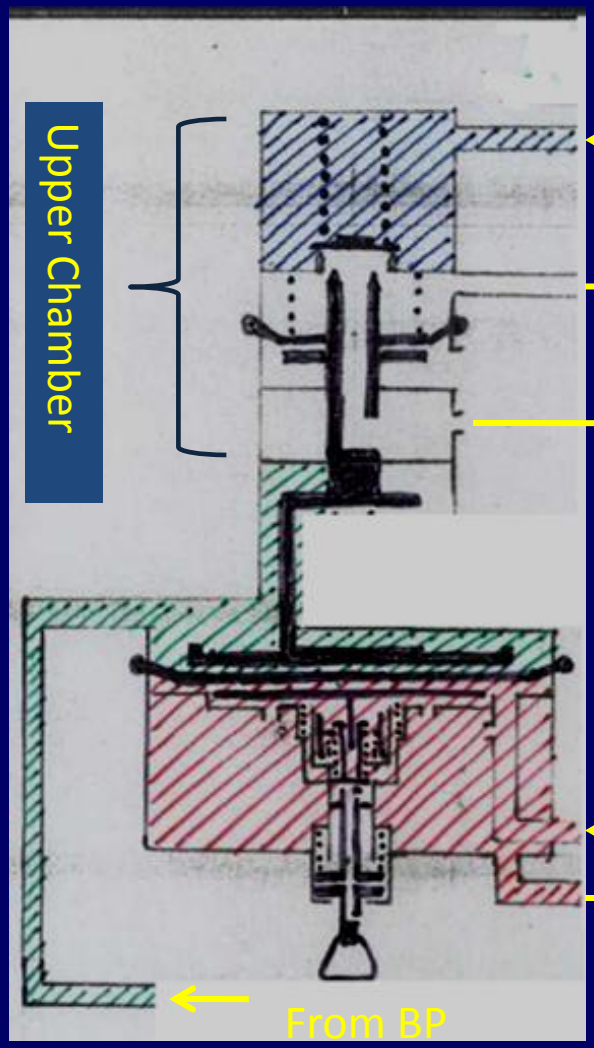
- Main subassemblies:
  - Three pressure valve
  - U-controller
  - ‘R’ charger & isolating valve with handle
  - Choke cover
  - Minimum pressure limiter
  - Maximum pressure limiter
  - ‘A’ controller
  - Quick release valve.

Working of Three Pressure Valve



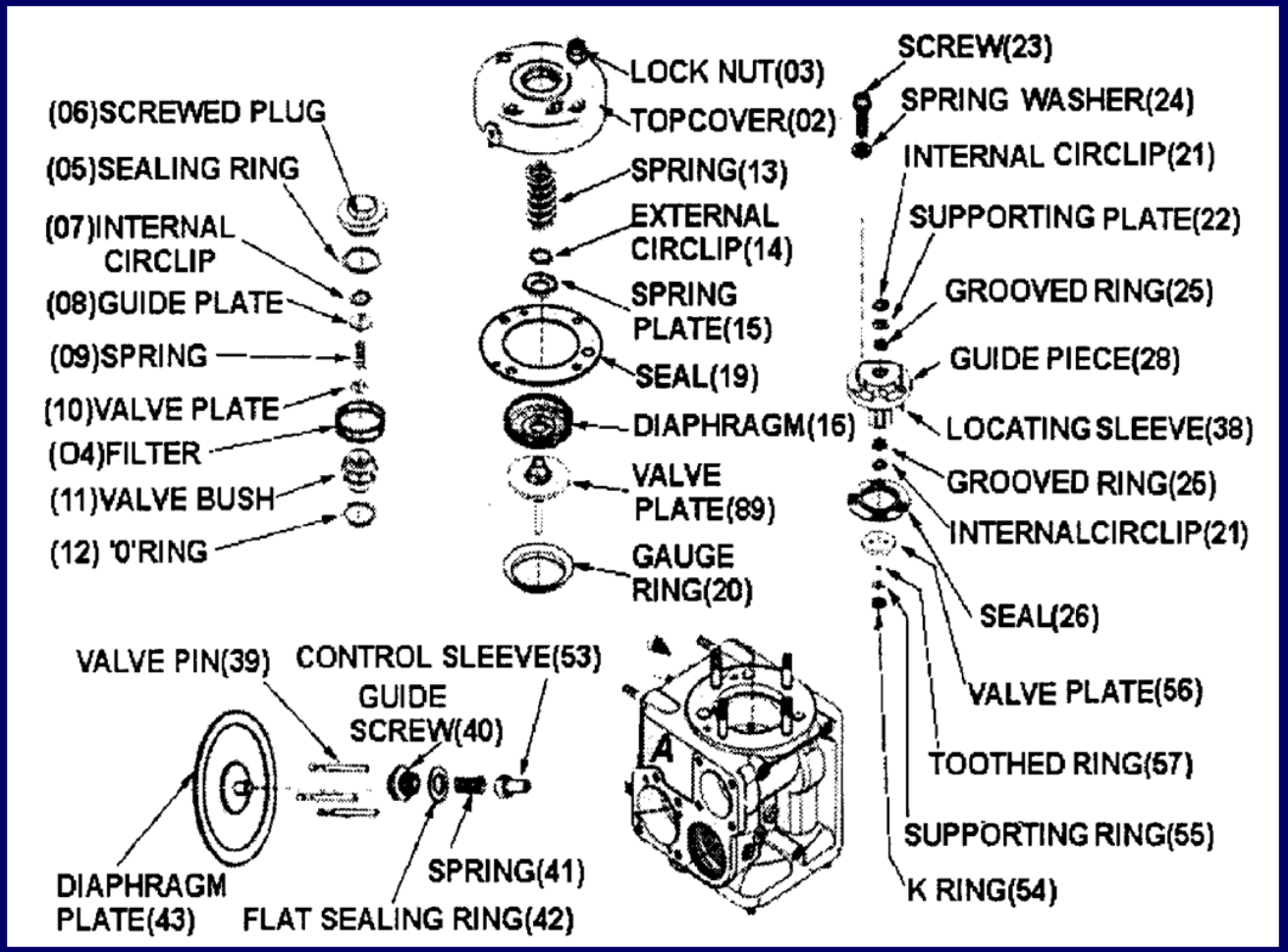
Three Pressure Valve

- Housed in the vertical central bore between the top and bottom face.
- Controls charging and discharging of BC in accordance with the change in BP pressure.

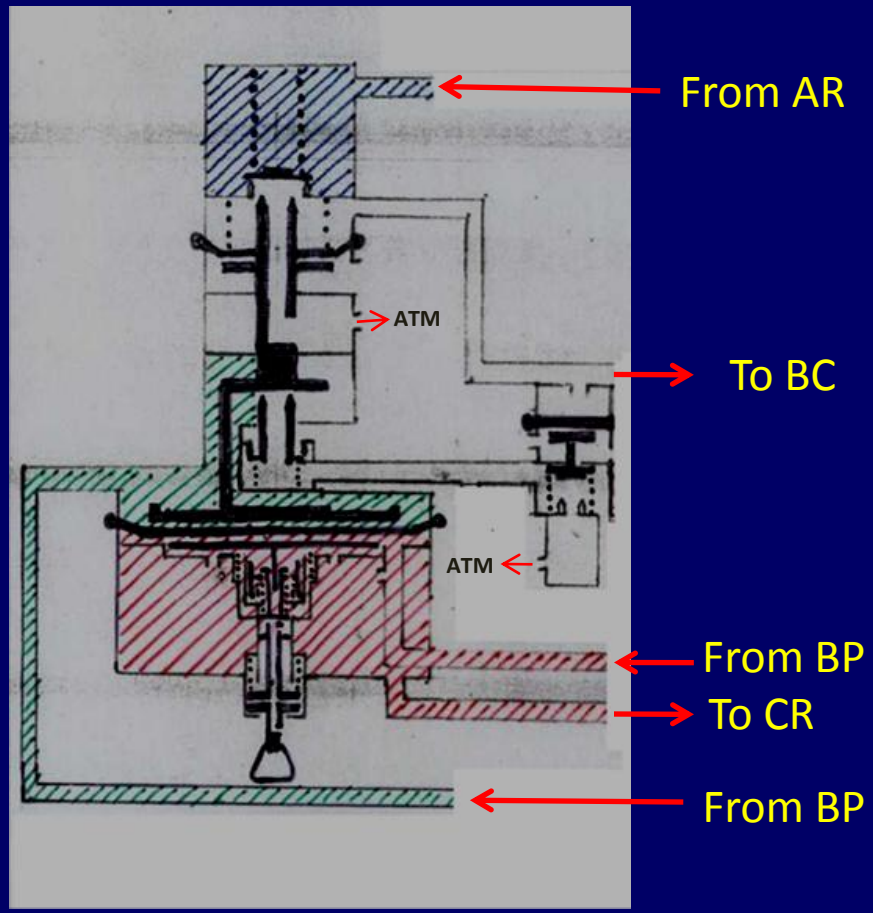


4 ZONES

Exploded View of Three Pressure Valve

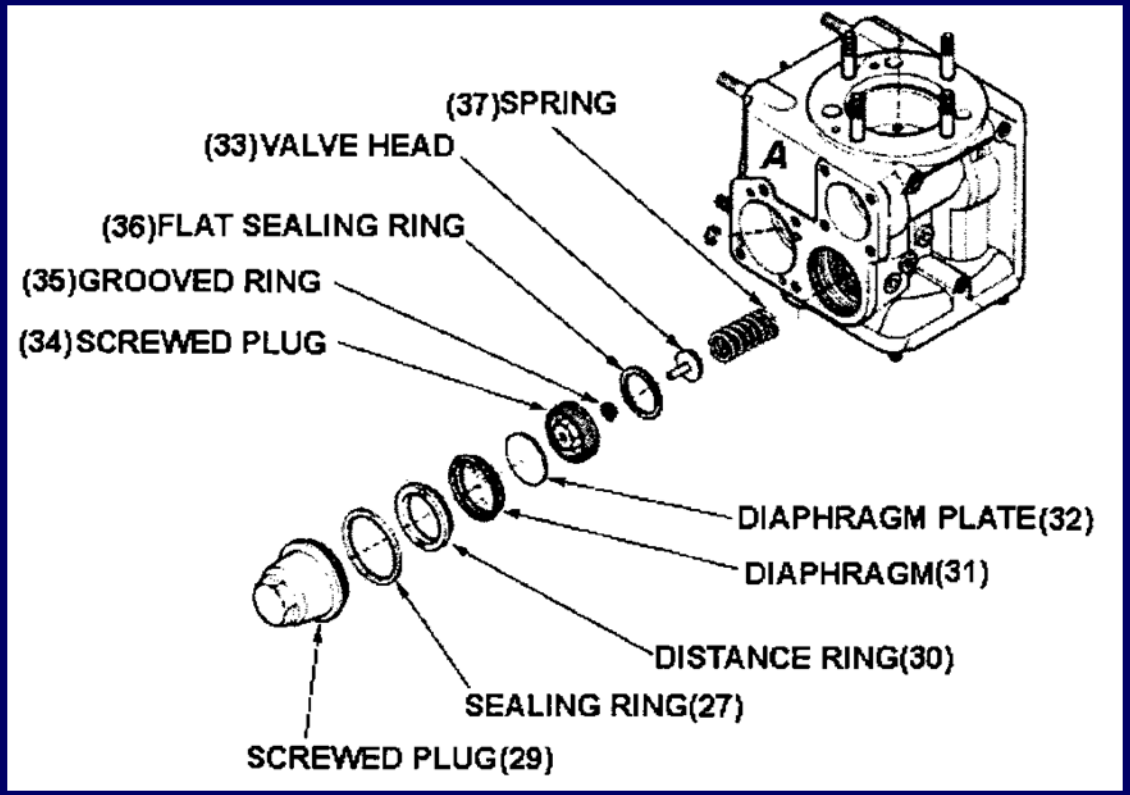


U-controller

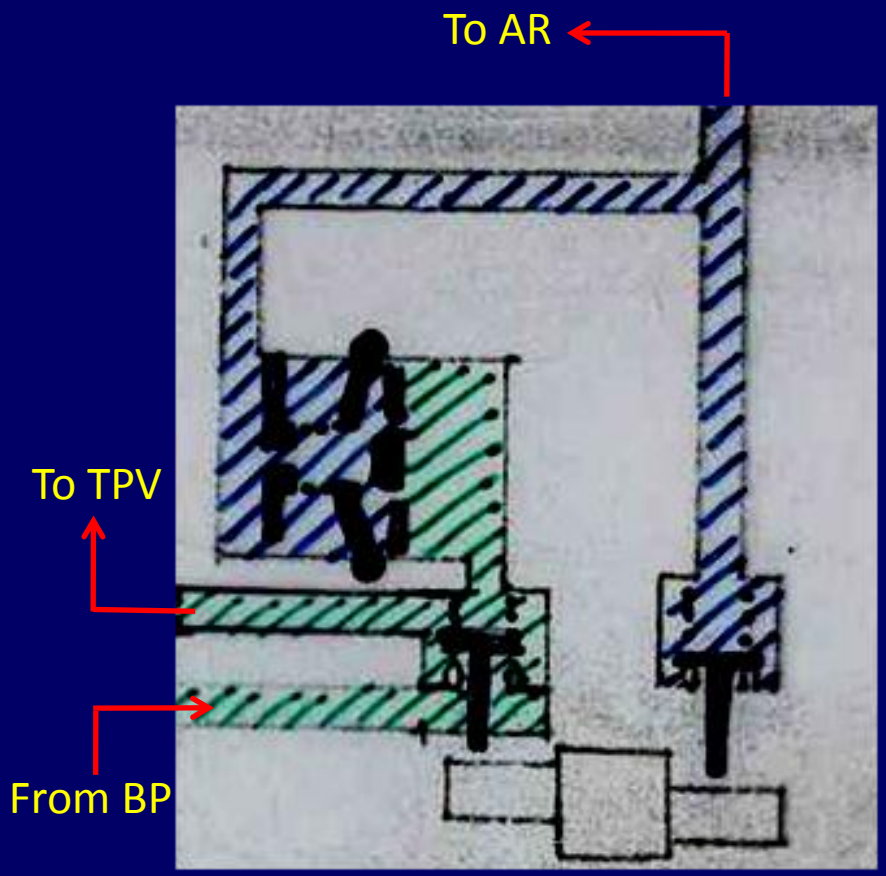


- Housed with R-charger & choke cover on one face of the DV.
- Taps off a small amount of BP pressure from DV during initial brake application till BC pressure reaches 0.8 kg/cm2.
- This action increases initial pressure reduction & causes simultaneous rapid propagation of braking impulse throughout the length of the train.

Exploded View of U-controller

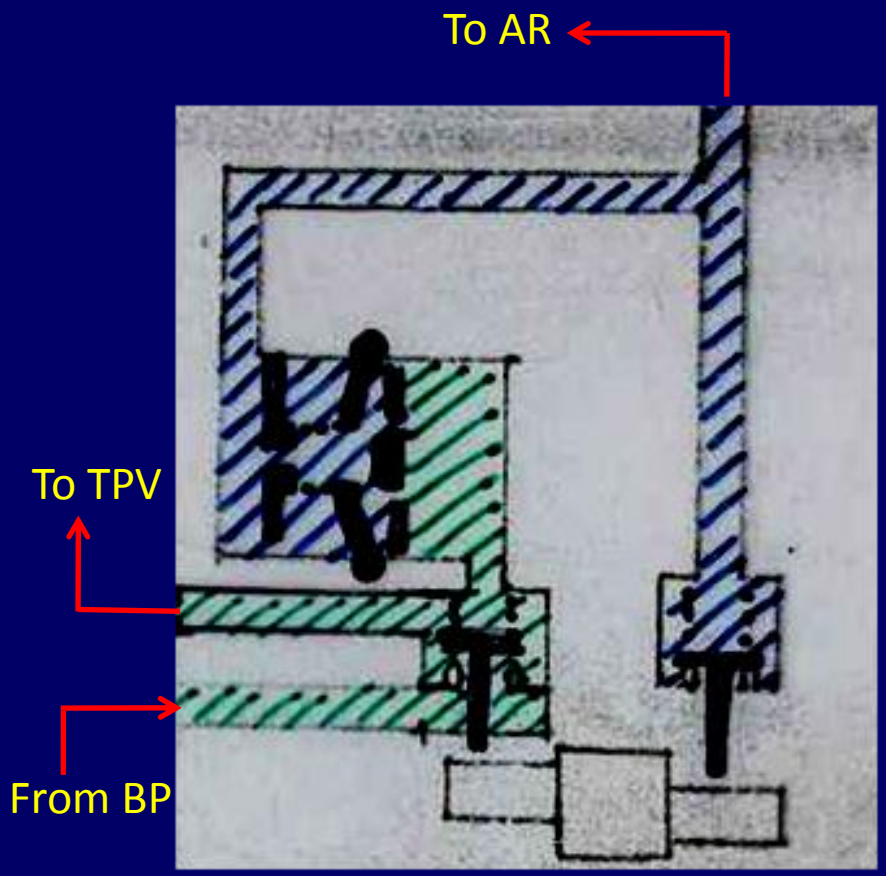


‘R’ Charger



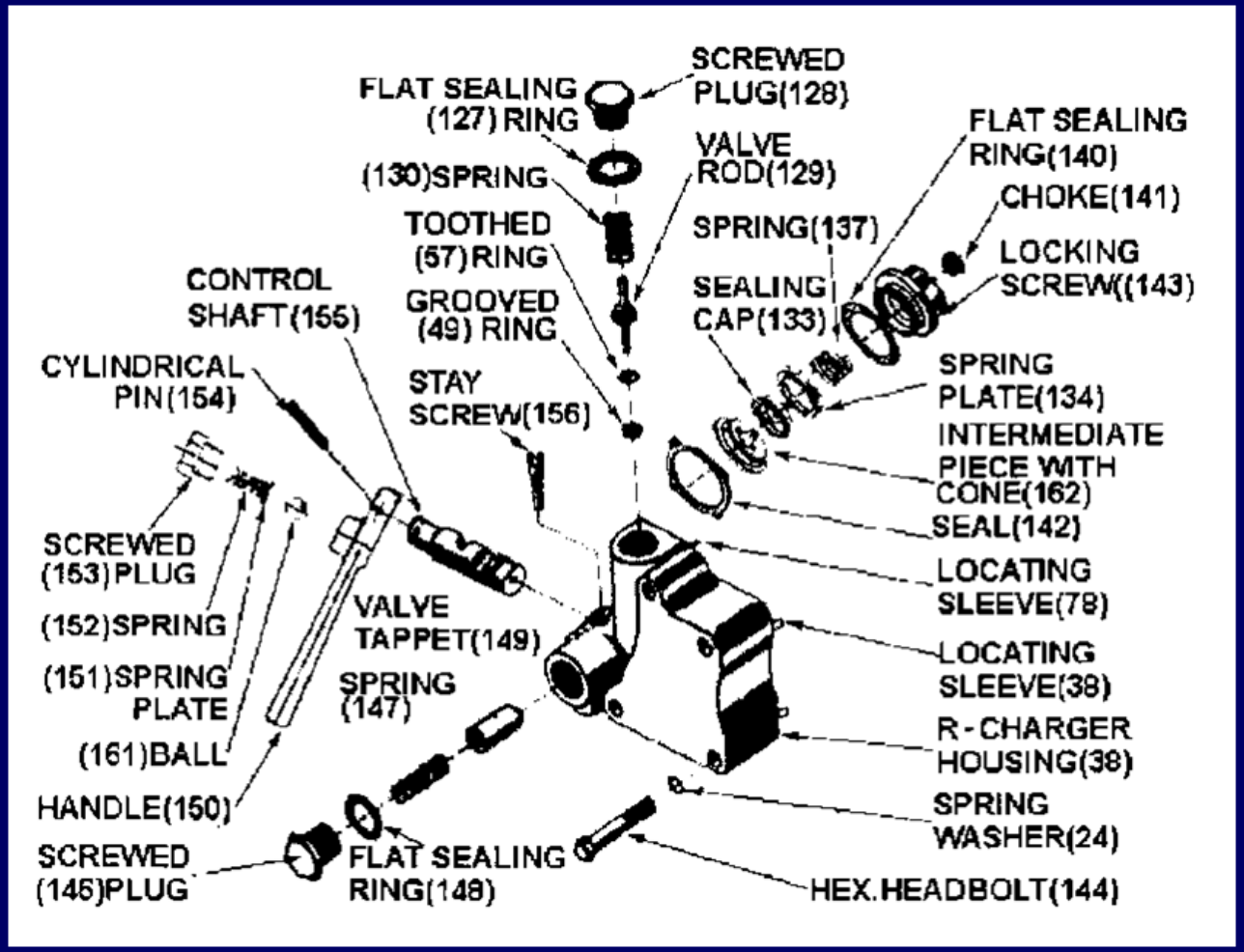
- Supplies compressed air from BP to AR when BP pressure is raised.
- Also separates AR from BP through a check valve (located inside) when BP pressure is less than AR pressure.

Isolating Valve with Handle

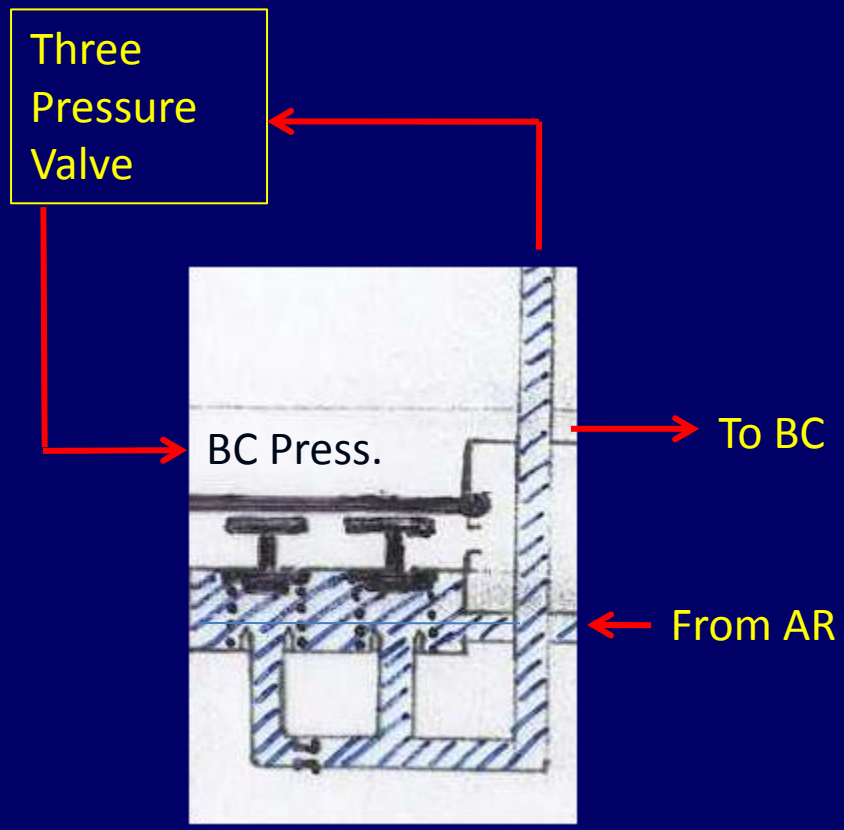


- Isolating valve with handle
  - Two positions:
    - Vertical – NORMAL
      - Connects BP to three pressure valve and R charger
      - Keeps AR isolated from ATM.
    - Horizontal – ISOLATED
      - Isolates three pressure valve and R charger from BP.
      - Connects AR to Atmosphere.

‘R’ Charger & Isolating Valve with Handle



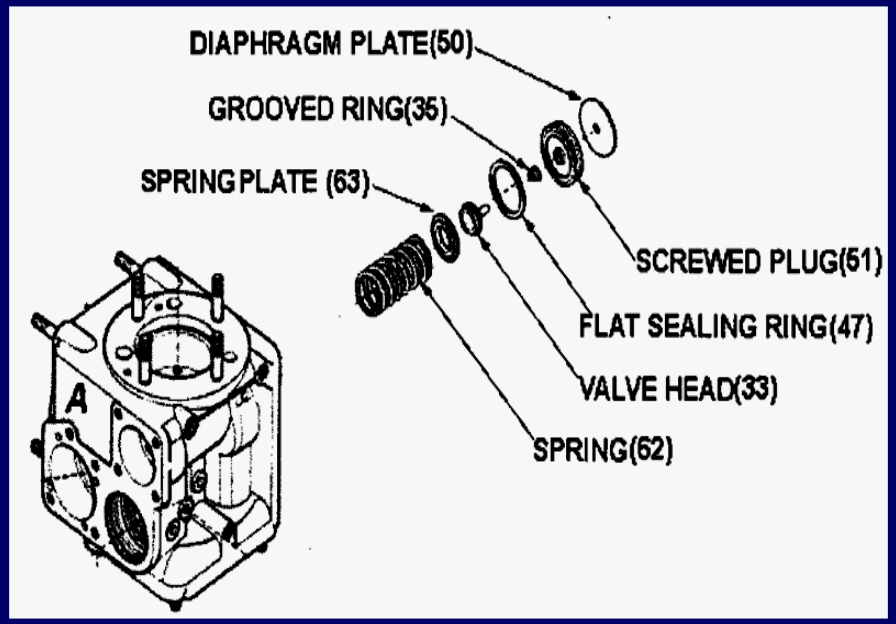
Minimum & Maximum Pressure Limiter



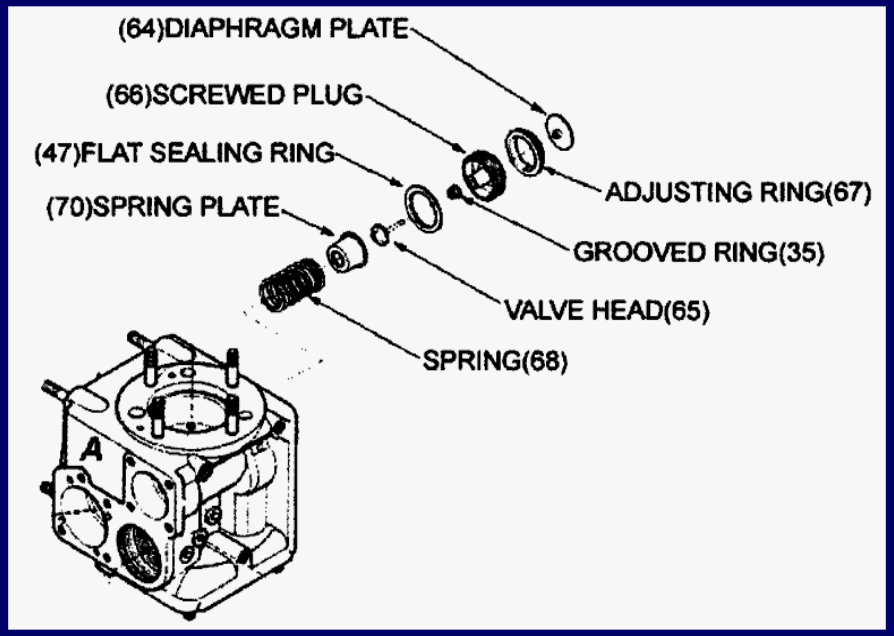
- **Minimum Pressure Limiter**
  - Housed with max. pressure limiter and 'A' controller.
  - Provides passage without choke to charge BC during initiation of brake application.
  - Helps in rapid charging of BC up to a pressure of 0.8 Kg/cm^2 to overcome rigging resistance.
- **Maximum Pressure Limiter**
  - Limits the maximum BC pressure to the required value irrespective of the BP pressure drop and AR pressure.

Exploded View

Minimum Pressure Limiter



Maximum Pressure Limiter



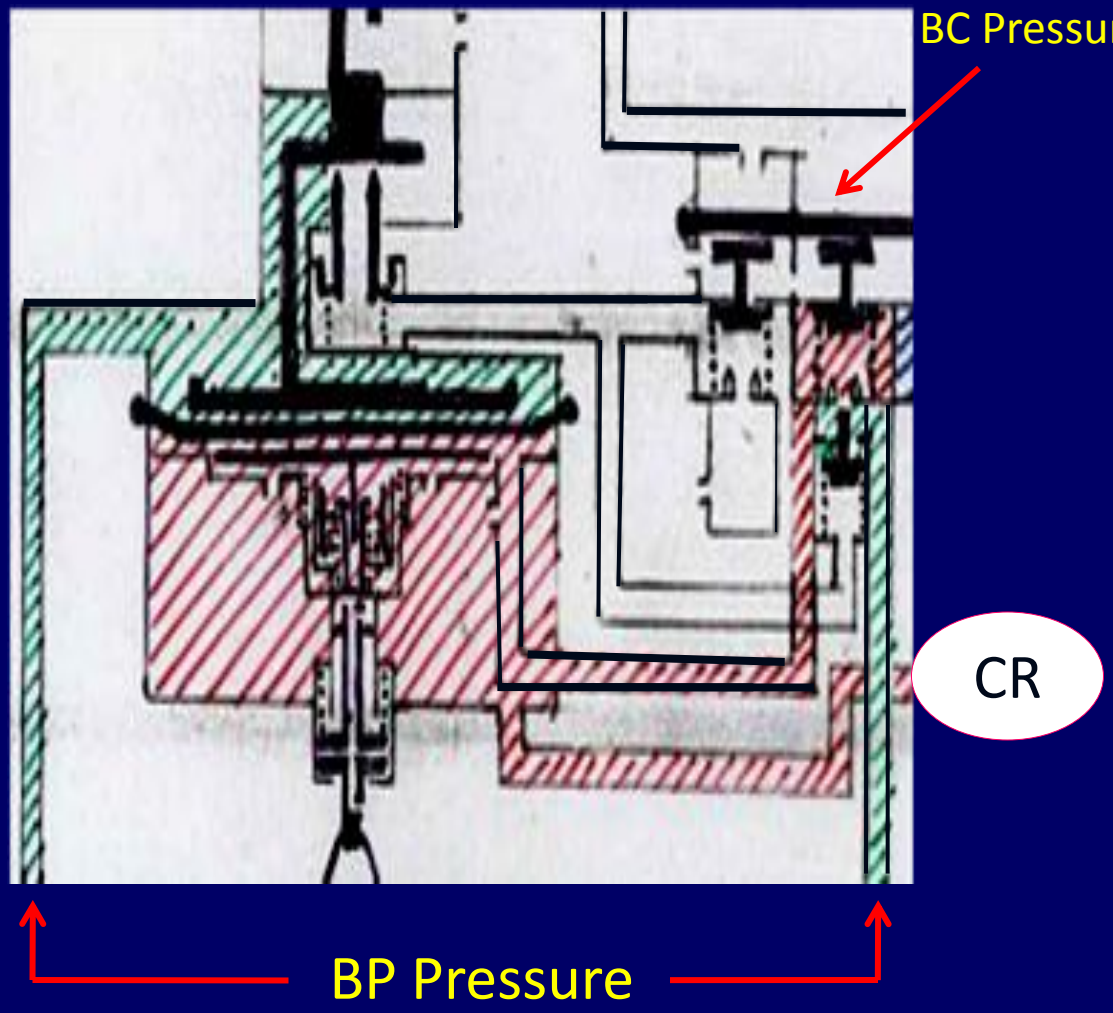
‘A’ Controller & Quick Release Valve

‘A’ Controller:

- Charges CR by BP pressure during charging stage,
- Isolates CR when brakes are applied i.e. BP pressure is reduced.
- Also protects CR to be overcharged.

Quick Release Valve:

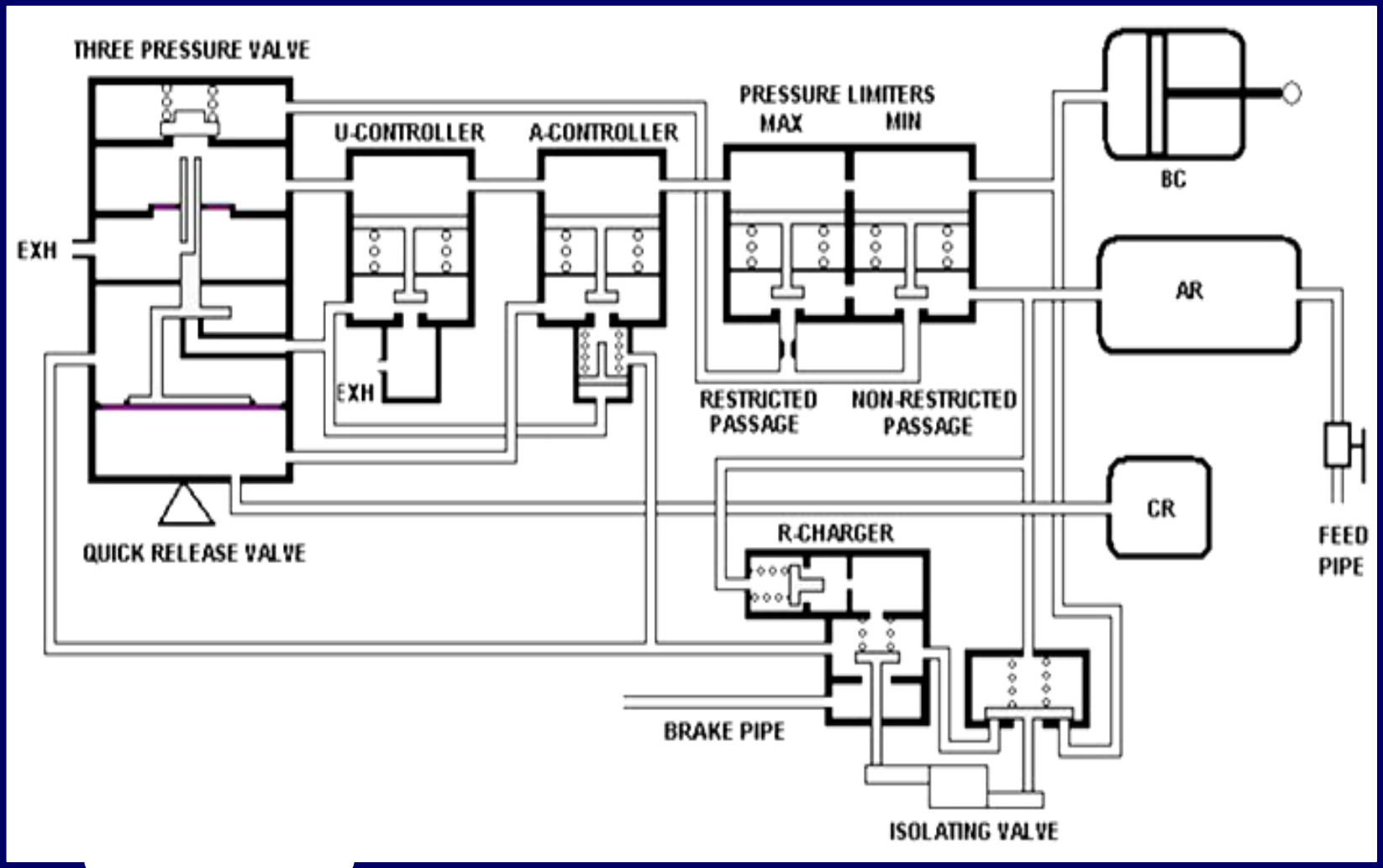
- Allows CR to be fully released by means of manually pulling of handle.



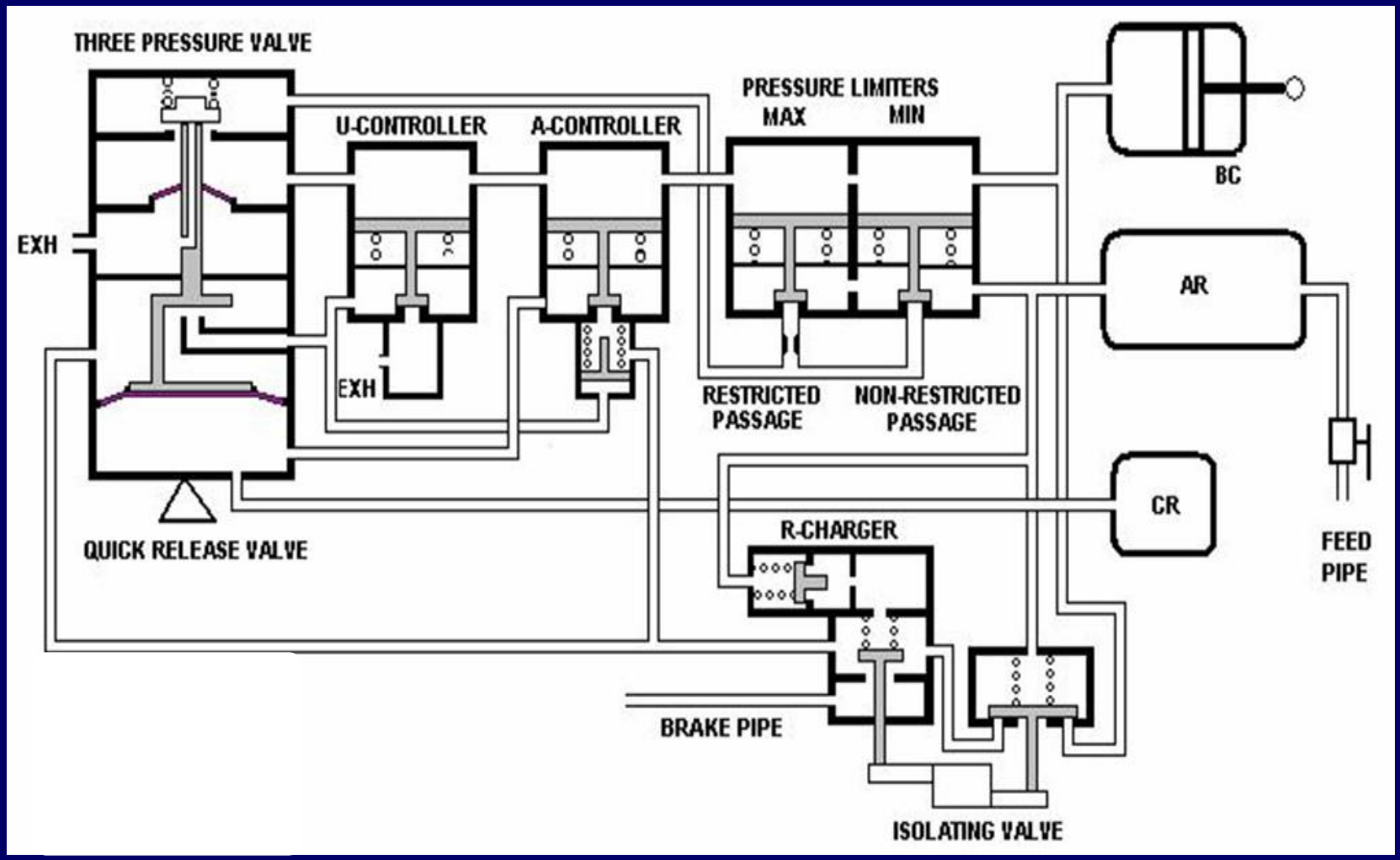
Functioning of KE type DV

- Charging stage
  - Charging of control reservoir
  - Charging of auxiliary reservoir
- Application stage
  - Emergency application
  - Graduated application
- Release stage
  - Graduated release
  - Manual Release

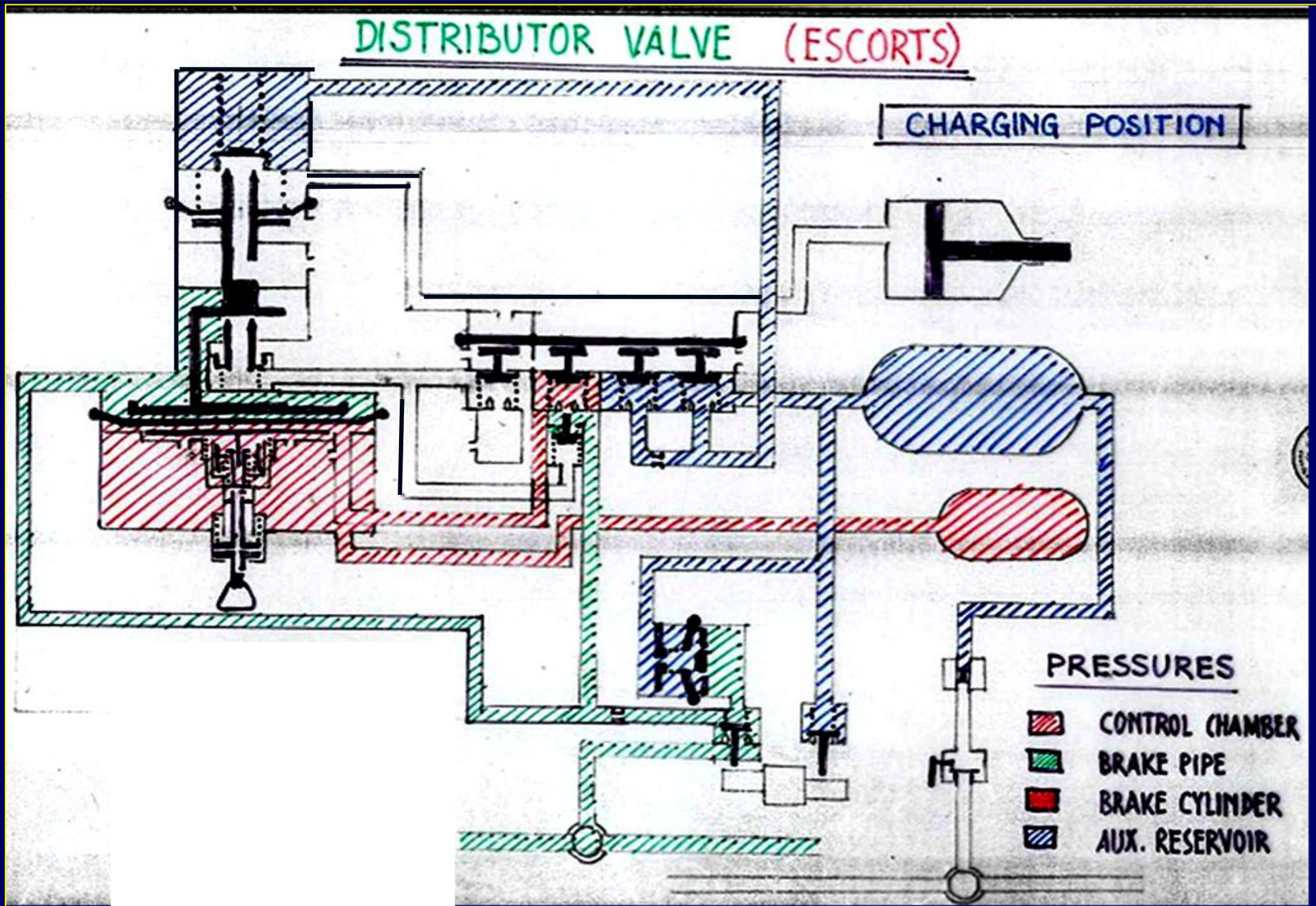
Charging Position of KE type DV



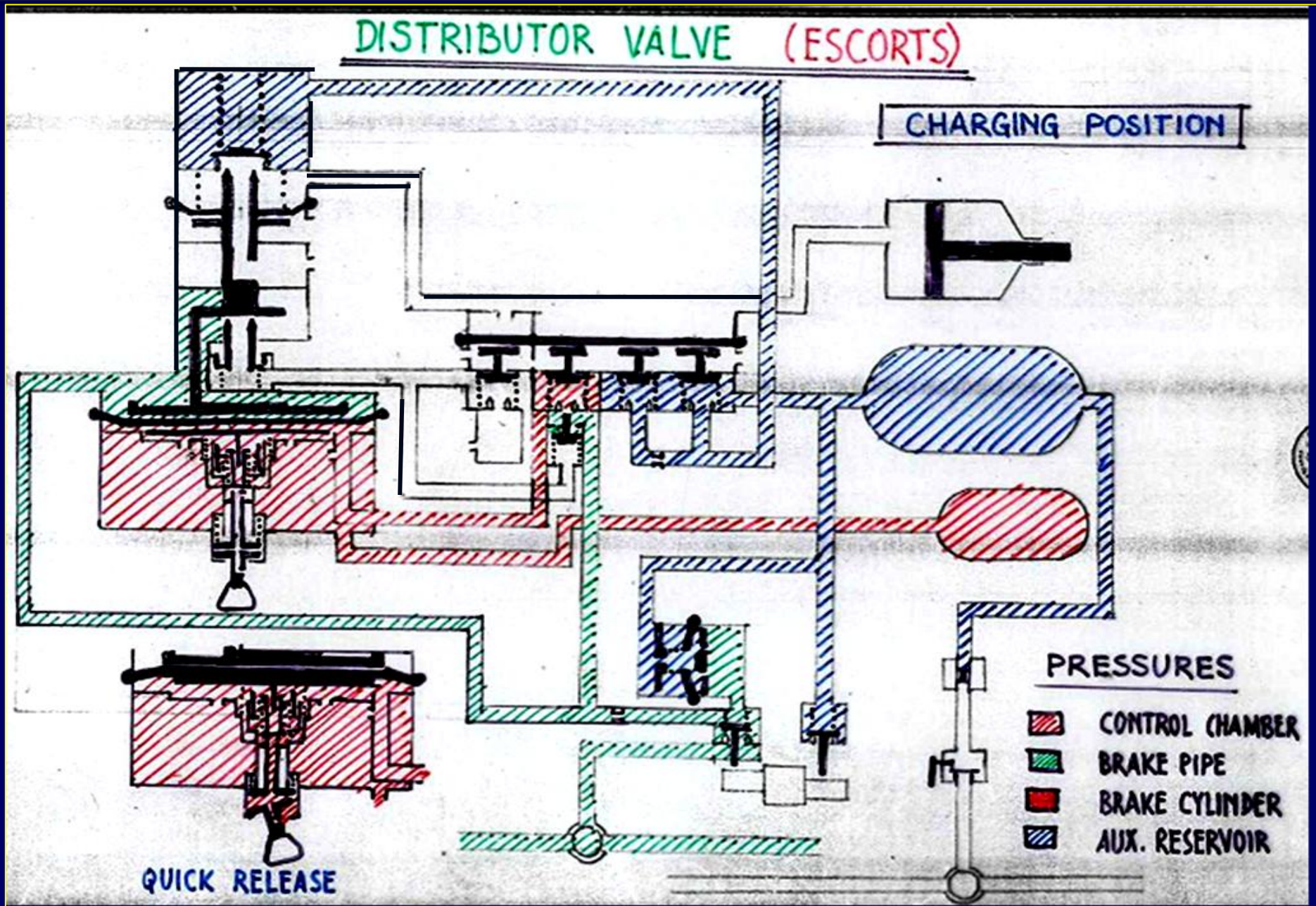
Application Position of KE type DV



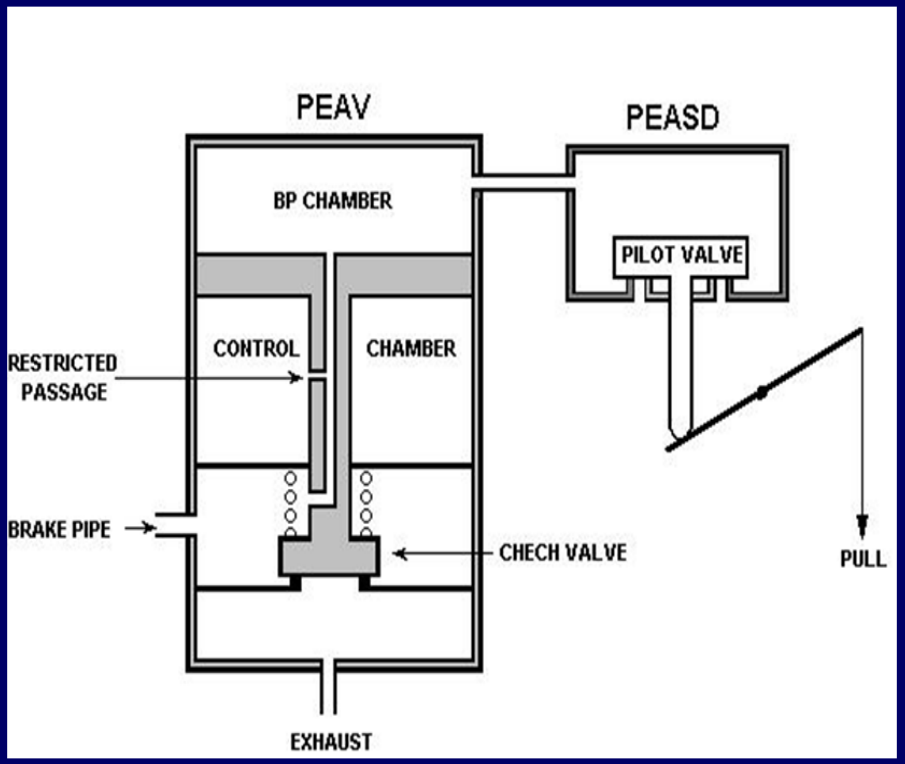
Charging Position of KE type DV



Charging Position of KE type DV



PEASD and PEAV

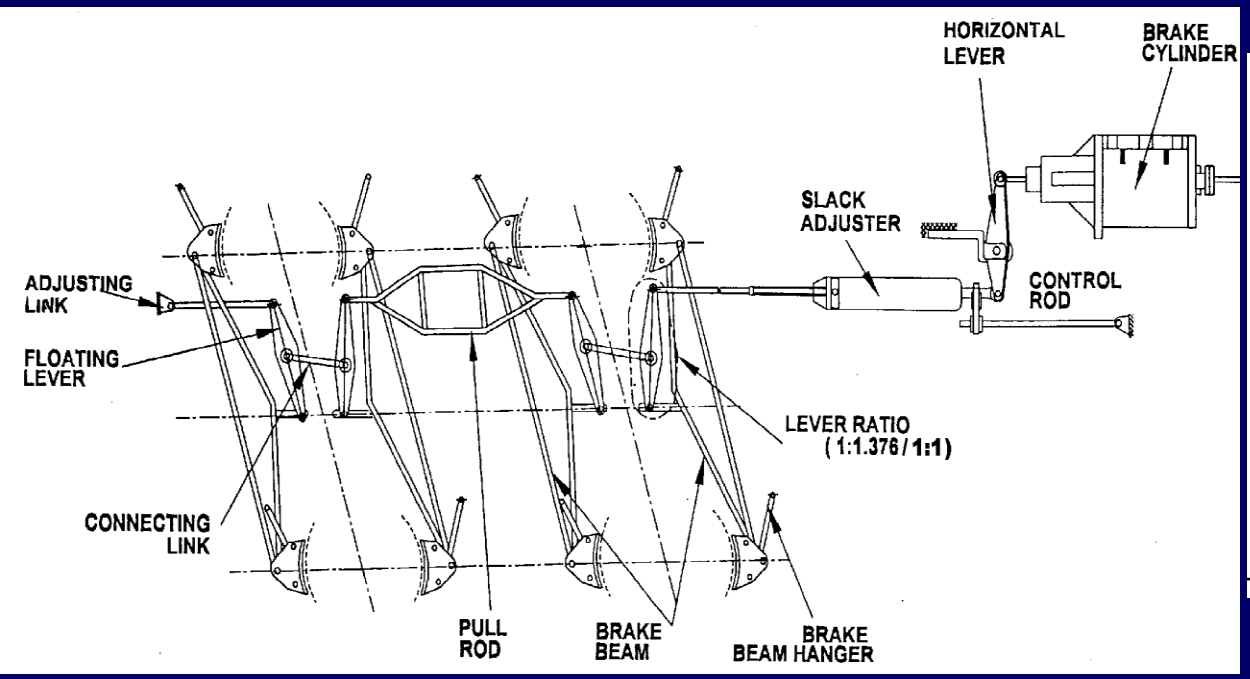


Brake Riggings (Brake Gear)

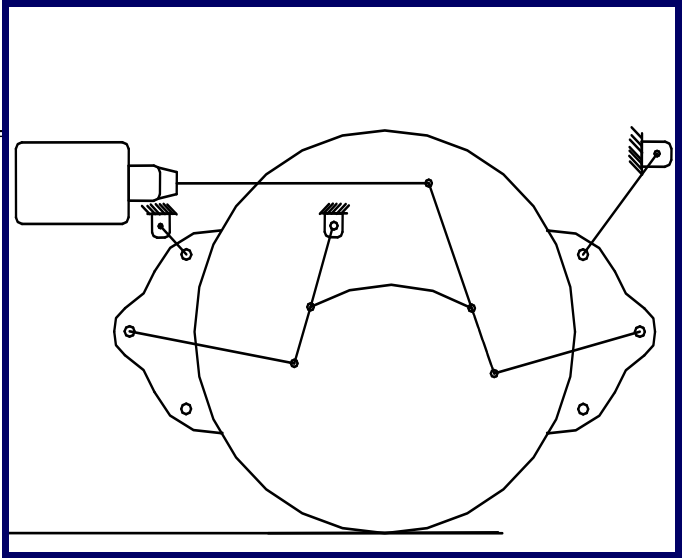
- Coaches
  - ICF Coach
    - Conventional BC fitted (Underframe Mounted)
    - BMBC fitted (Bogie Mounted)
  - LHB Coach
    - Axle mounted disc brake
  - Some other examples
    - Brake applying on wheel disc or wheel trade.
- Wagons
  - Conventional BC fitted with
    - ELB device or
    - Load Sensing Device (LSD)
  - BMBC fitted wagons with
    - Load Sensing Device (LSD)
    - Automatic BC Pressure Modification Device (APM)

Brake Rigging of ICF Coach

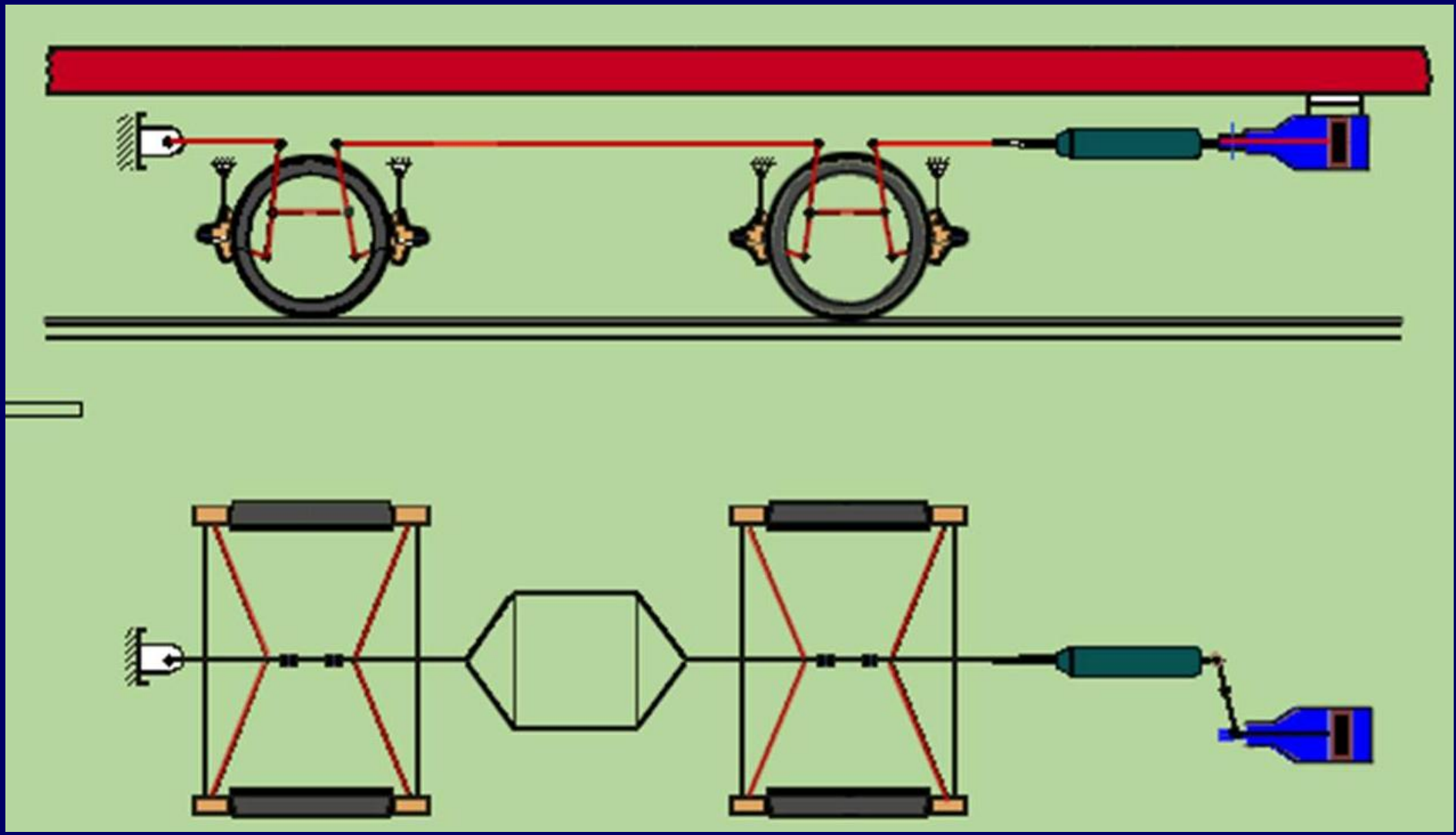
Underframe Mounted



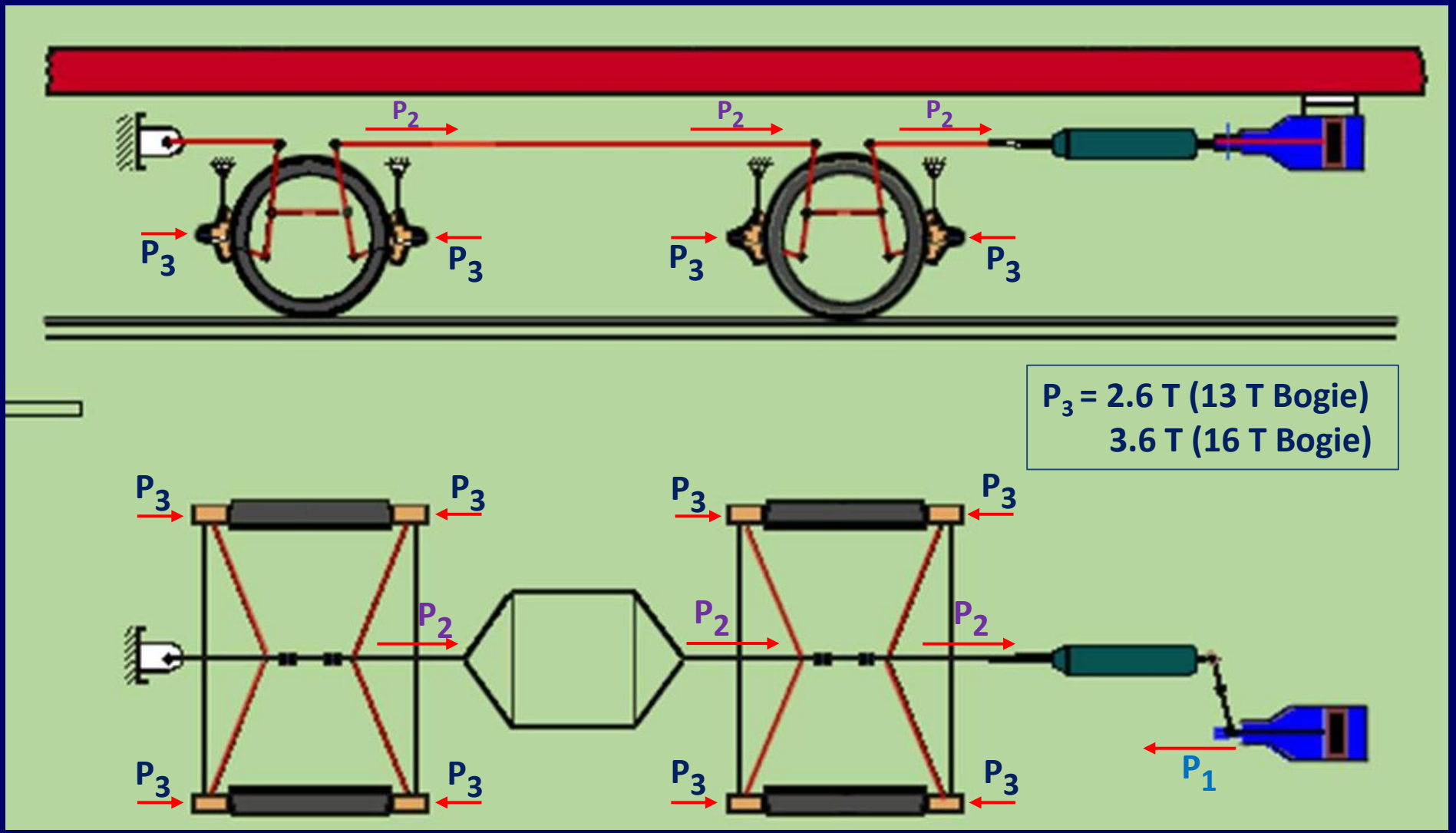
Bogie Mounted



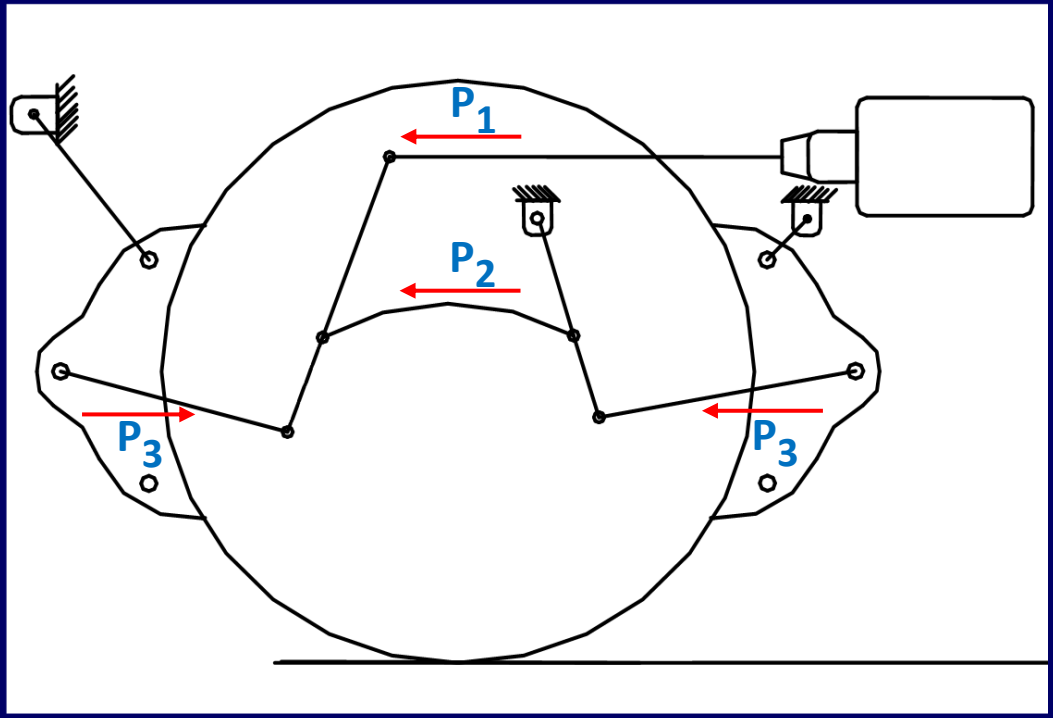
Brake Rigging of Conventional ICF

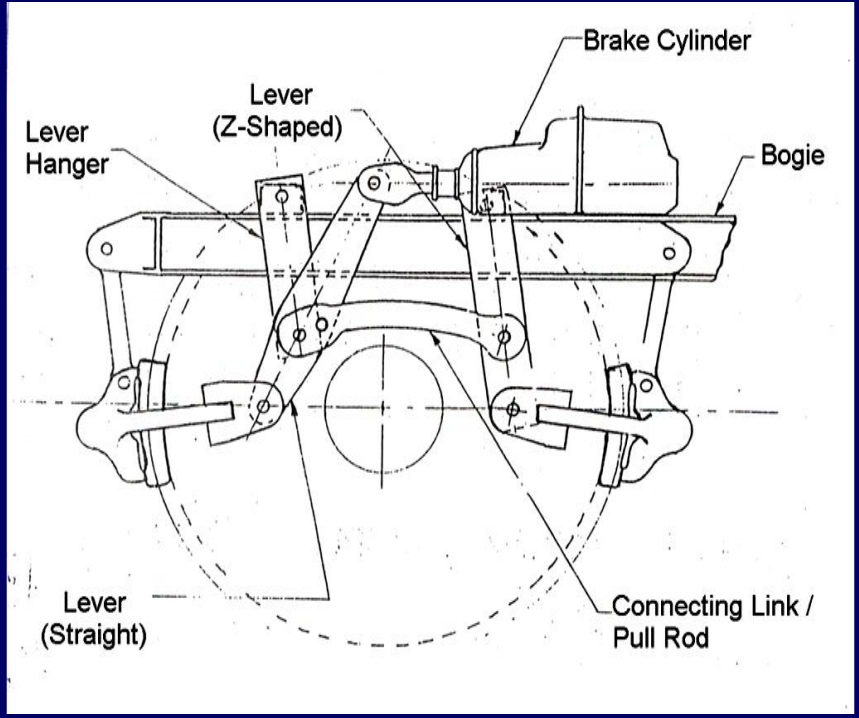


Braking Force Calculation (ICF Convensional)



Brake Rigging of ICF (BMBS)





Total force available on one brake block

= area of BMBC x max. BC pressure x leverage ratio x ½

= $\pi/4 \times (8 \times 2.54)^2 \times 3.8/1000 \times 1.9$ or $2.1 \times ½$

= 1.17 T for 13 tonnes or

1.29 T for 16 tonnes

Clearance in Brake Rigging (Slack)

- Brake block clearance.
- Brake gear bush-pin clearance.
- Scope of increase or decrease in clearance.
- Effect of slack on brake system.
- Std. gap between brake block & wheel tread
  - whether required and how much ?

Slack Adjustment

- Necessity of adjustment of gap (wear aspects).
- Slack adjustment to be taken up
  - Equivalent of total wear of wheel & brake block.
- Automatic slack adjuster: two types
  - External SAB slack adjuster
  - In-built slack adjuster
    - Single acting
    - Double acting

External SAB slack adjuster

- Fitted in Underframe mounted system stocks
- Dimension ‘e’: Slack adjustment capacity
  - 375 ± 25 mm for coach.
  - 575 ± 25 mm for wagon.
- Dimension ‘A’: Control dimension to maintain Std. gap.
- Rapid action double acting.
- Maintainability much poor.

IN-built slack adjuster

- Much better maintainability
- Piston stroke is control dimension to maintain Std. gap
- Adjustment capacity:
  - 305mm (ICF coach) against 395mm requirement.
    - Therefore one time manual adjustment required in whole life of wheel i.e. after reaching wheel dia 839mm
  - 500 mm (wagon) against 456 mm required.
    - Manual adjustment not required at all.

DEVELOPMENTS IN BRAKE SYSTEM

Developments in wagon

- U/frame mounted to bogie mounted system.
- Fitment of automatic load empty device.
  - Load Sensing Device (LSD) in U/f mounted system.
  - Automatic Pressure (BC) Modification (APM) Device in bogie mounted system.

Developments in coach

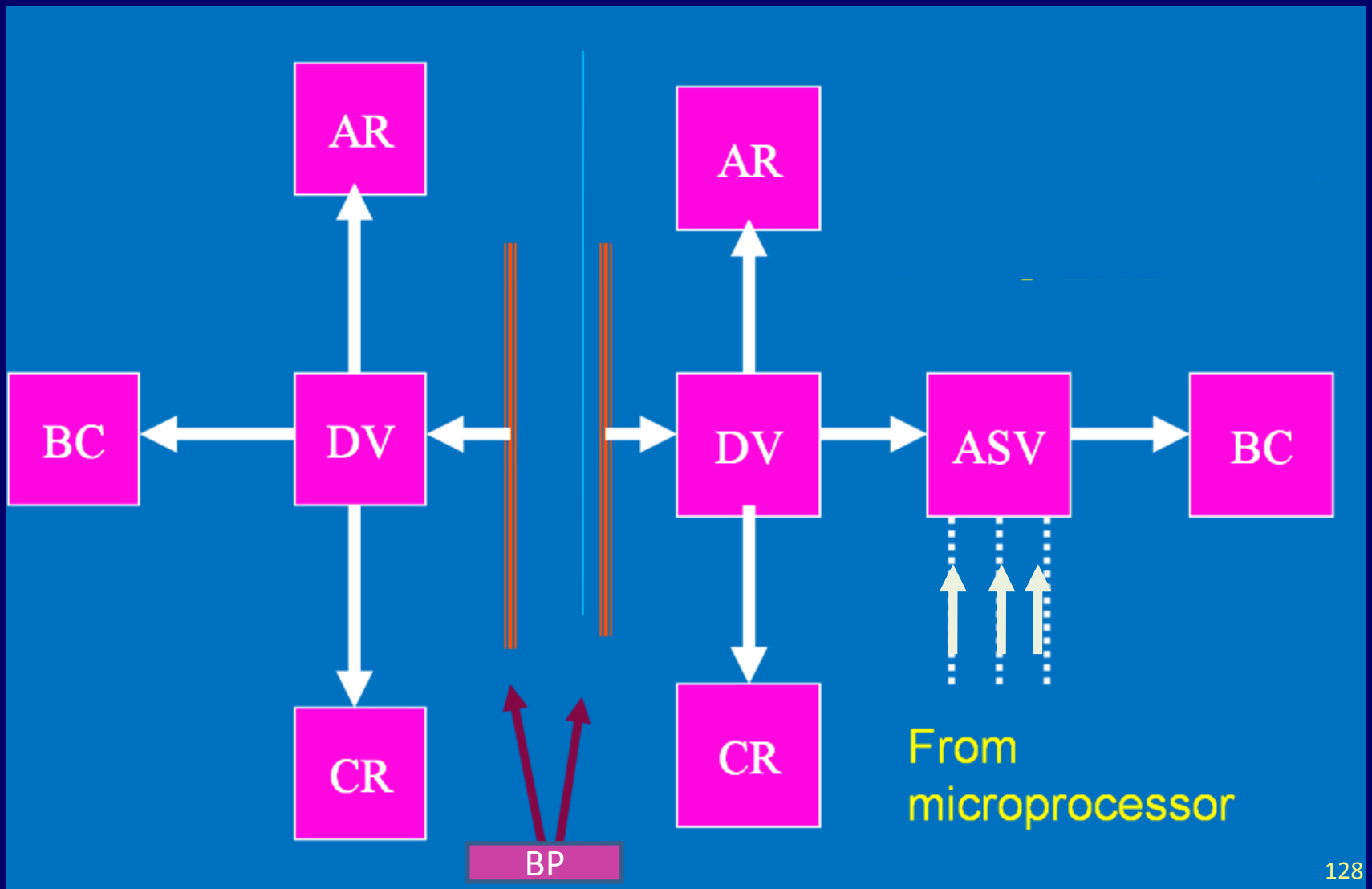
- U/frame mounted to bogie mounted system.
- Axle mounted disc brake system in LHB coach.
  - WSP (Wheel Slide Protection) fitted.
- EP brake system in DEMU coach

LHB COACH BRAKE SYSTEM

Salient Features

- Almost no brake rigging.
- Microprocessor based WSP.
- Wheel turning frequency reduced.
- Centralised control for complete coach.
- Use of Emergency Brake Accelerator for sharp emergency application in complete train set.

Schematic Diagram: ICF vs LHB

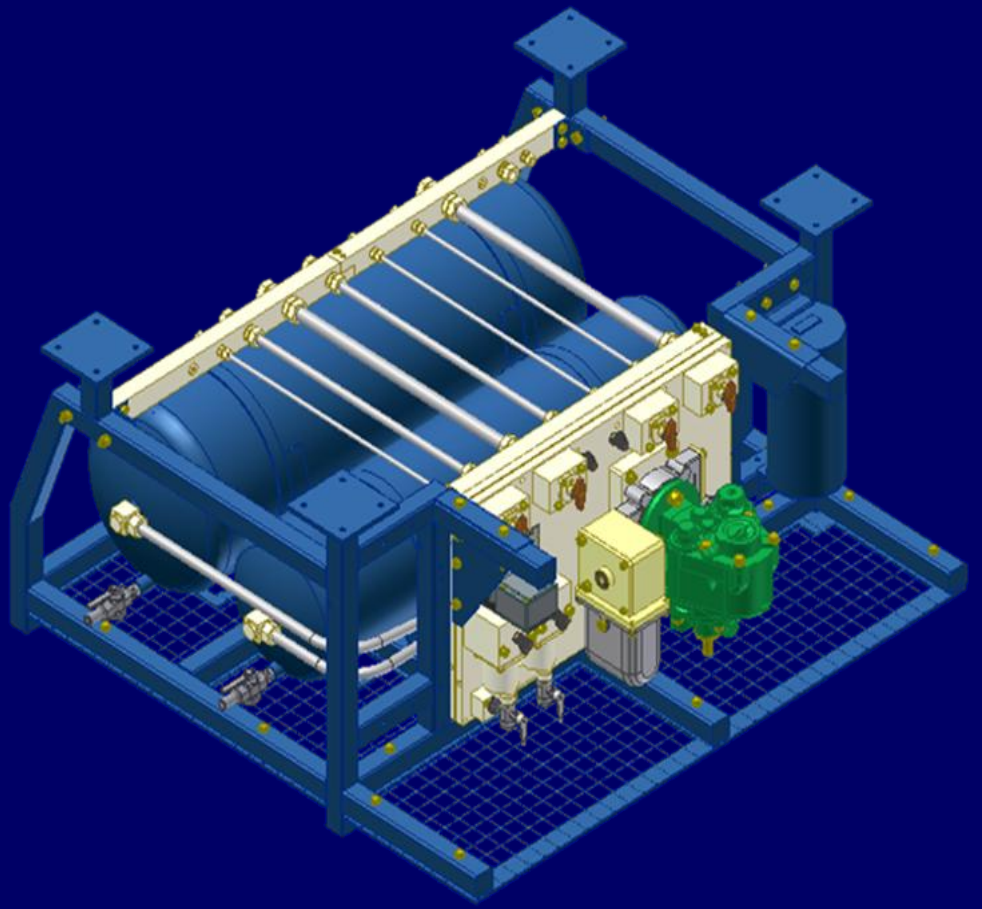


MECHANICAL AND PNEUMATIC SYSTEM OF LHB BRAKE

Brake Equipments on Under frame

Brake Container

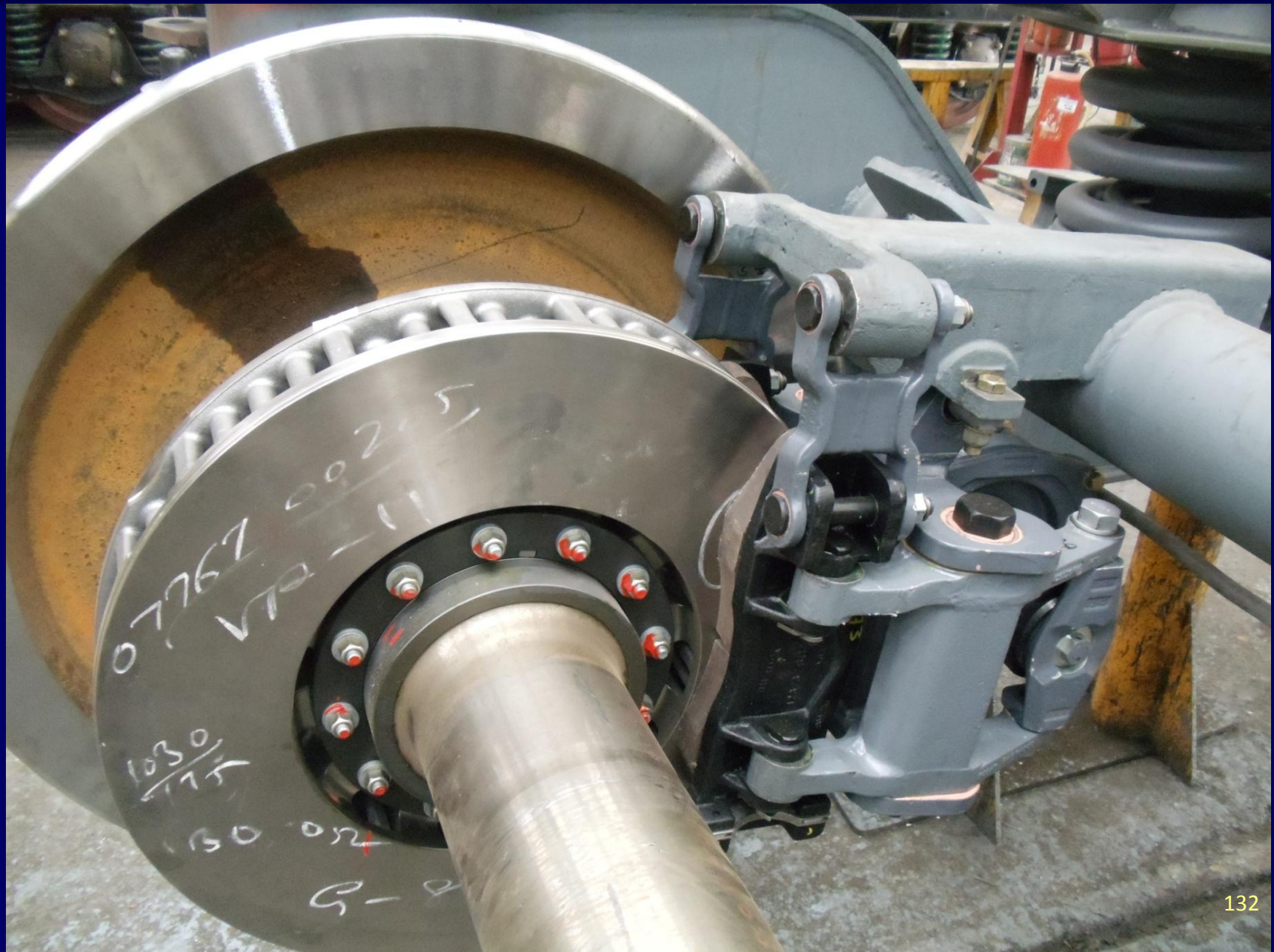
- Consists of
  - Brake control panel
  - Reservoirs
    - One 125L for brake application only (Protected by check valve)
    - One 75L for toilets as well as brake
    - One Control reservoir 6L for DV
- Weight -350 kg (with all equipment)



Brake control panel

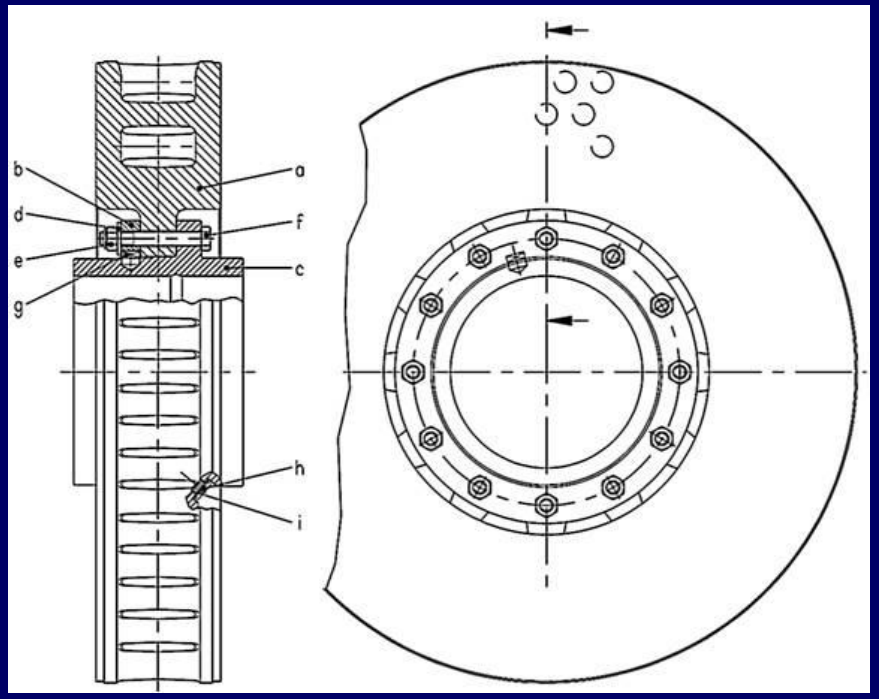
- Consists of:
  - Test fittings (To Check FP, BP, CR & BC Pressure)
  - Isolating cocks for F P, Toilet, Bogie-1 and Bogie-2.
  - Filters for BP and FP
  - Distributor valve
  - Pressure switch (to operate WSP)
  - Check valve.

Brake Components on Axle



Brake Disc

- Consists of
  - A gray cast iron friction ring(a) with integral
    - Crosswise cooling ribs
      - Carry off the heat.
    - Hub (c)



a. Friction ring
b. Clamping ring
c. Hub
d. Spring washer
e. Hexagon nut
f. Hex-head bolt
g. Anti-twist stud
h. Screw plug
i. Sealing ring

Brake Equipments on pipe line

- Emergency Brake accelerator
  - Actuates on any rapid pressure reduction in BP, equivalent to emergency application.
  - Allows the BP to vent locally via a large orifice.

WHEEL SLIDE PROTECTION

Concepts of Motions

- Roll
- Slip
- Slide
- Skid

Requirement of WSP

- Poor Adhesion
- Because of high speed as 160 km/h and the EBD of 1200 m, the adhesion could be insufficient to sustain the brake rate demanded during emergency breaking, especially when the surface of the rail is wet and slippery.

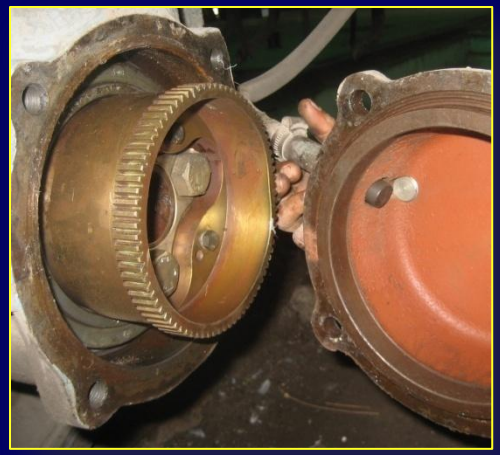
Introduction of WSP

- A BC pressure regulation device.
- Adjusts the braking force to the wheel-rail friction (adhesion) so as to
  - Make optimum use of available adhesion
    - To optimize the braking distance and
    - To prevent wheel sliding.
- For 160 kmph & above WSP is recommended as must requirement.

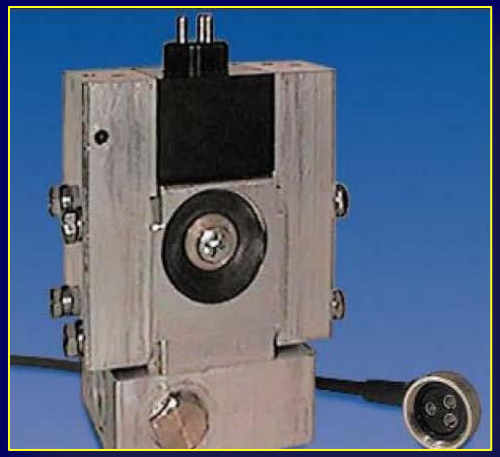
Main Components

- The system consists of:
  - Speed sensor,
  - Anti skid valve/dump valve,
  - Microprocessor control unit and
  - Pressure switch.

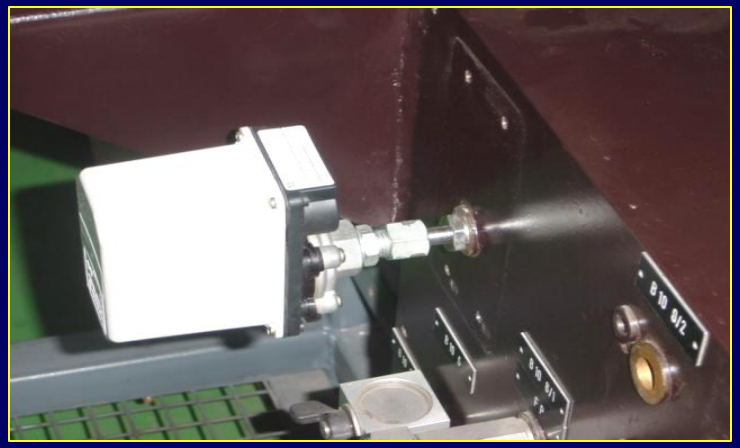
Main Components



Phonic wheel and
Speed sensor



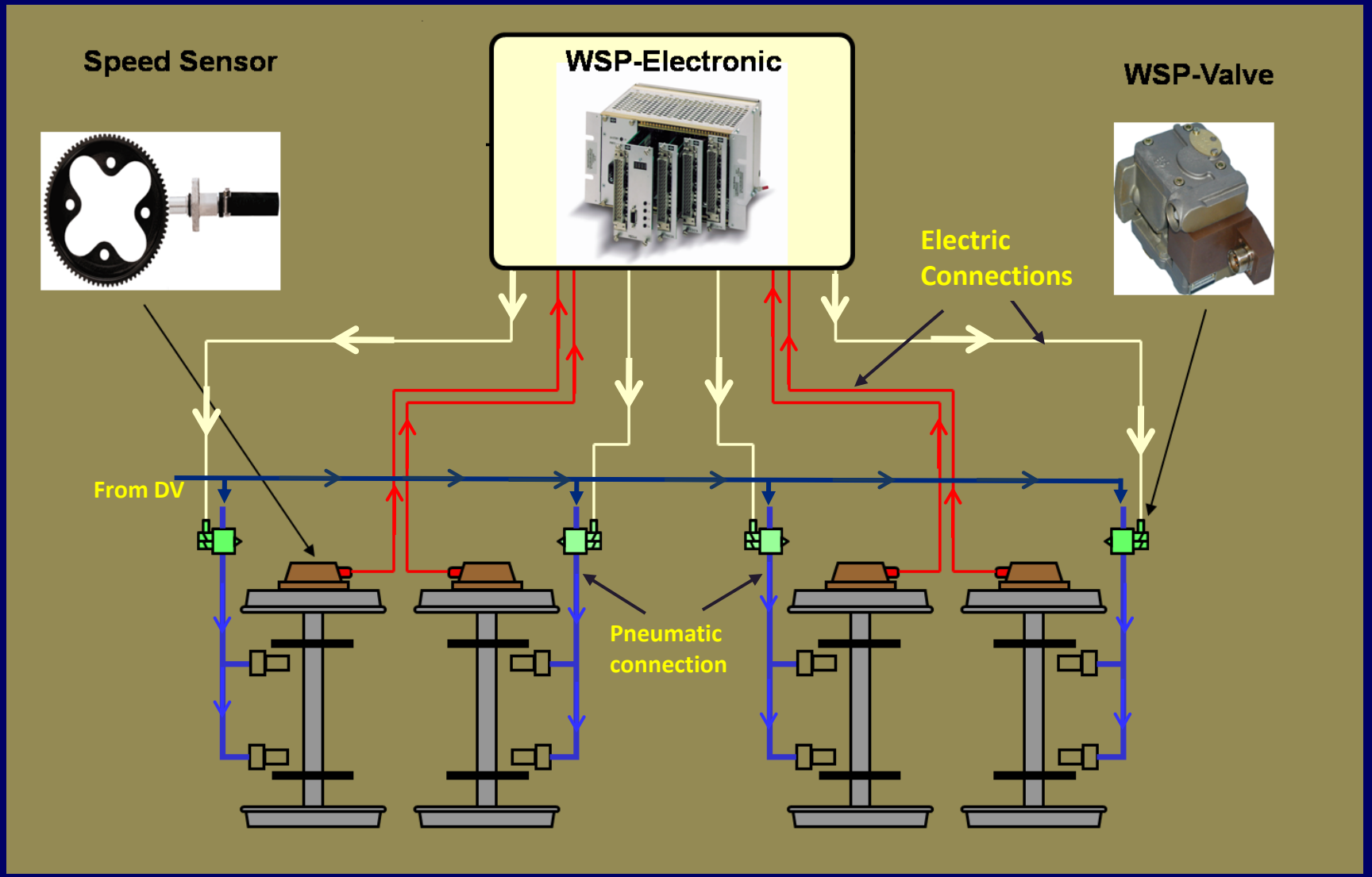
Anti skid valve/dump valve



Pressure switch

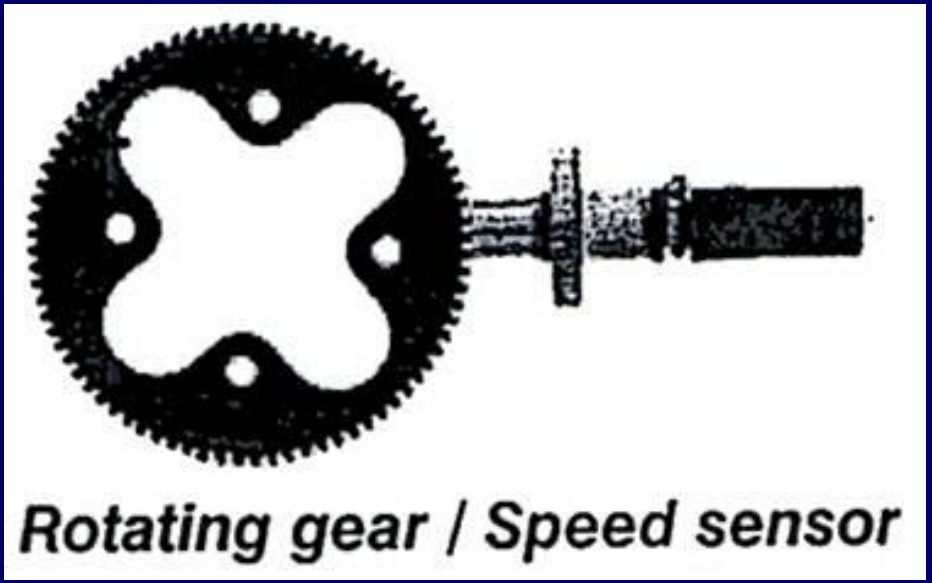
Microprocessor control unit

Pneumatic & Electrical Connections



Speed Sensor (pulse generator)

- Comprises
  - A magnetic sensor and
  - A teethed gear.
- Gap is maintained between teethed gear and sensor.
- No wear.



Rotating gear / Speed sensor

Microprocessor Control Unit

- Analyse all 4 input speed sensor's signal frequencies.
- Evaluates all the frequencies.
- Generates signals for anti-skid valve to control the BC pressure.

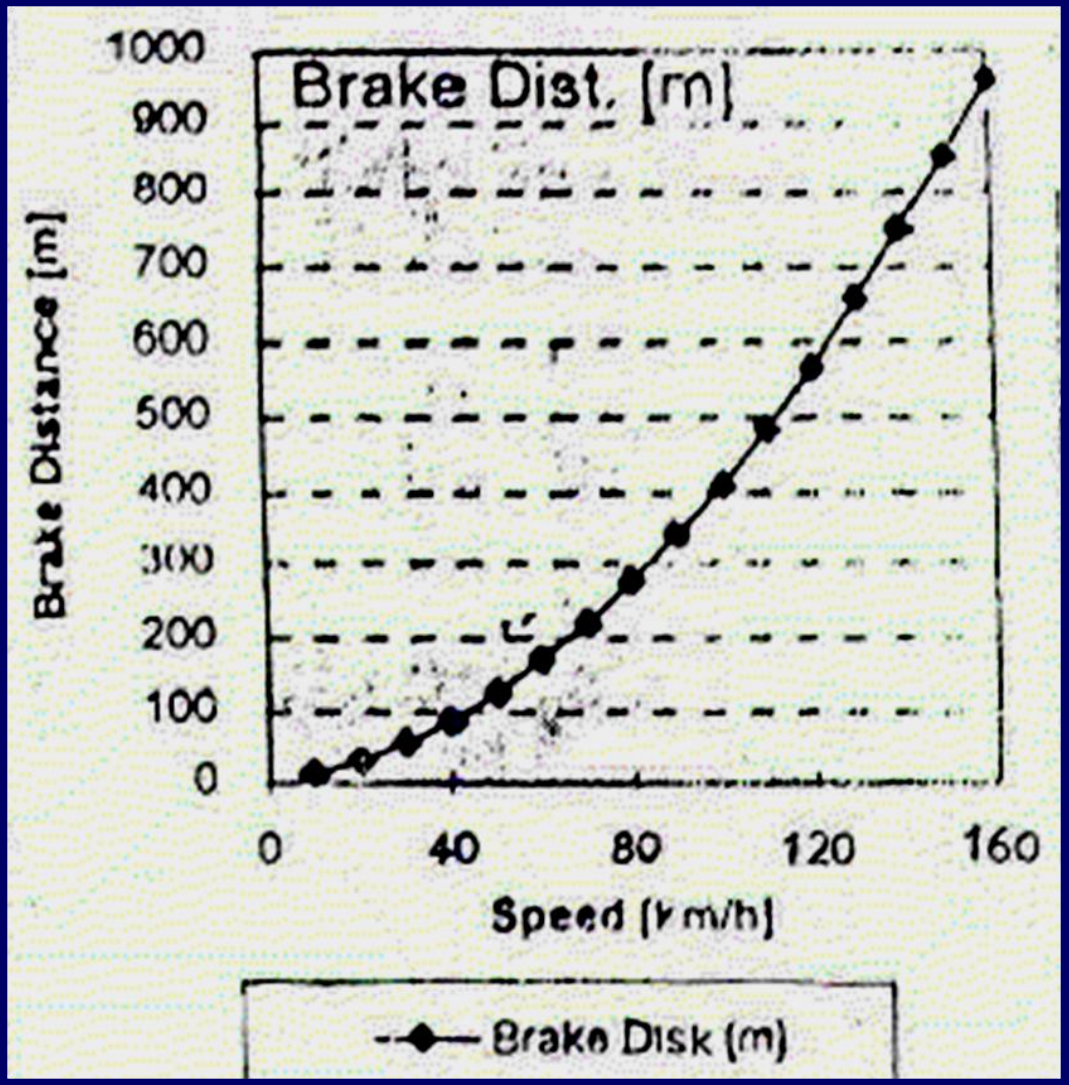
Braking Distance w.r.t. Speed of Train

Composition of Train

2 Loco+

2 Powercar+

16 C/Car



Braking Distance Test Results

- Designed Braking Distance: 1200m at 160 kmph
- Results of braking distance trial of 18 coaches loaded-16 C/car+1EC/car+1P/car at 160kmph
  - Dry rail condition,
    - Emergency application- 1077 m.
    - Full service application- 1312 m.
  - Wet rail condition
    - Emergency application- 1094 m.

Wheel Slide Protection Principle

- Operates as a BC pressure regulation device.
- Made up of two micro processor-
  - Driven modules which control the state of adhesion of the axles.
  - Supervisor module for diagnostic purposes.
- In the case of change of state of the adhesion, the device
  - does not interact with the pneumatic system, but
  - every moments, it adjusts the braking force to the present adhesion conditions.

Wheel Slide Protection Principle

- System implements 4 axles-4 channels configuration and visualizes the use of 4 pneumatic devices for each axle.
- The intervention affects one axle at a time and is of the tachometric (speed comparison) and accelerometer type.
- Speed signal derived also for CDTS.

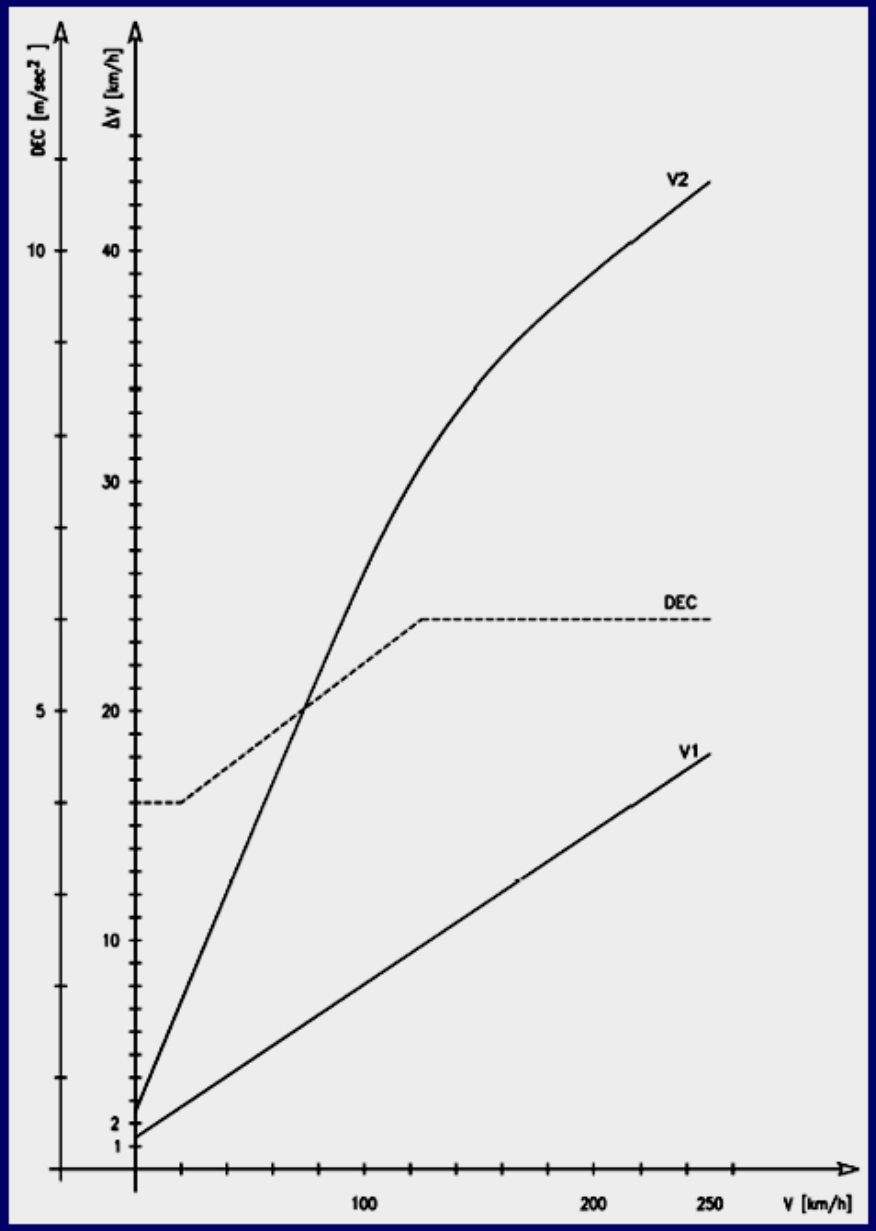
Development Of The Threshold Speed

- Upper threshold speed
  - Above which the axle involved is loosing adhesion.
  - A fixed 1.5km/h + approx. 6% of the real speed is referenced.
- Lower threshold speed
  - The threshold speed gap according to the real speed of the vehicle, above which the axle involved is considered as “skidding” by the system,
  - The air pressure is discharged from the respective BC.
  - A fixed 2.5km/h + approx. 25% of the real speed is referenced up to app 100km/.

Development Of Deceleration Criteria

- DEC
  - The maximum allowed deceleration for each axle above which the BC pressure is modulated.
  - The discharge of the BC may take place although the V2 threshold was not exceeded.
- The V1, V2 and DEC are a function of the instant speed of the vehicle.
- The ACC criterion is a fixed value.

Real Speed to V1, V2 and DEC Gr



Speed and Accelaration Criteria

- Speed comparison (V1):

$$V1 = Vr - \left(1.5\ km/h + \frac{6 * Vr}{100} \right)$$

- Speed comparison (V2):

$$V2 = Vr - \left(2.5\ km/h + \frac{25 * Vr}{100} \right)$$

- Axle negative acceleration criterian(DEC):
- Axle positive acceleration criterian(ACC):

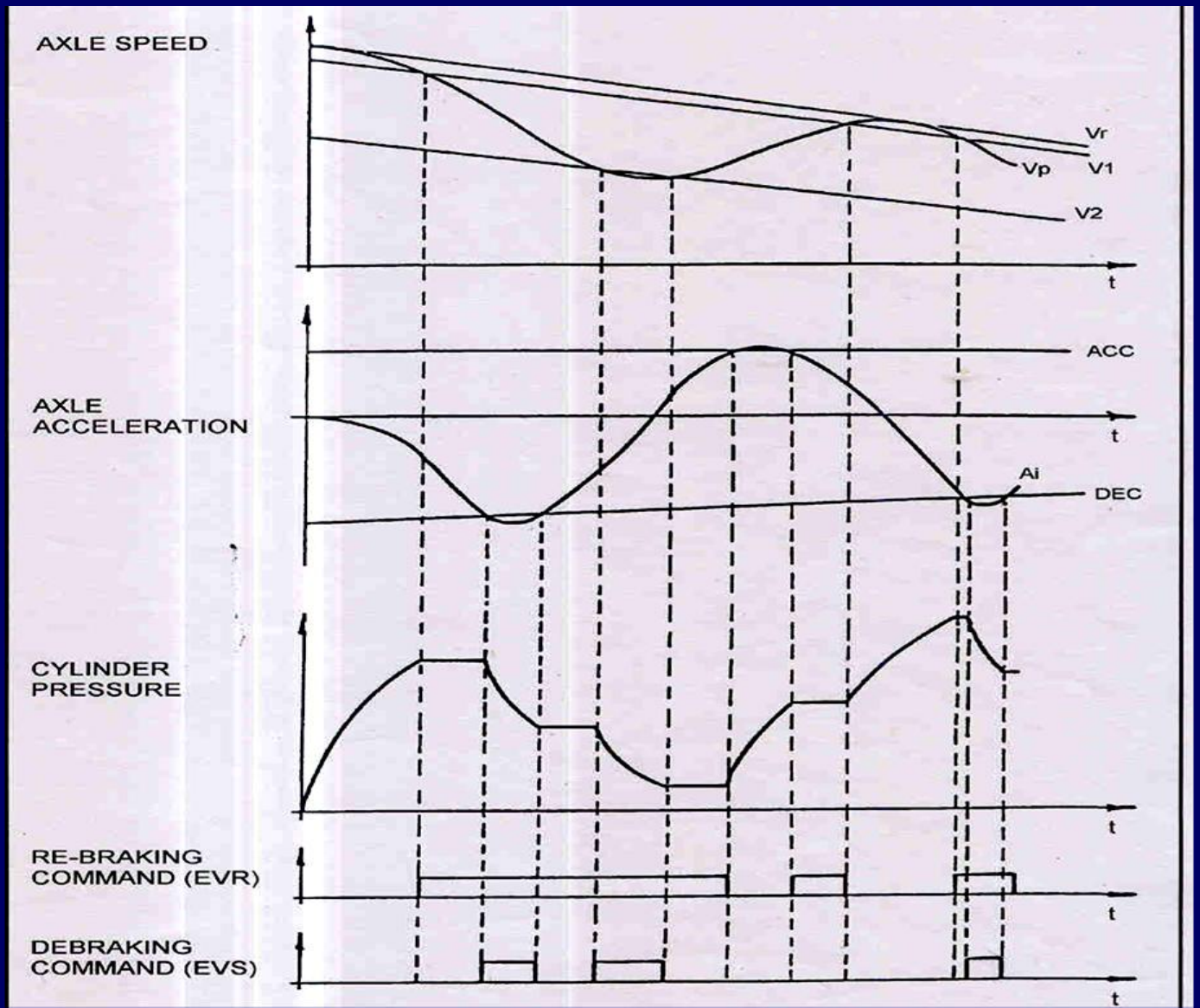
Speed Computation

- Reference speed (Vr):
  - An estimate of the real speed of the vehicle.
  - Device takes the fastest axle's speed as Vr.
  - If all the axles lose adhesion simultaneously,
    - The DEC criteria is followed until at least one axle regains adhesion.
- Peripheral speed measurement (Vp):
  - BC pressure is regulated by ASV,
    - In order to keep Vp between V1 and V2, i.e. the most favourable zone for restoring adhesion.

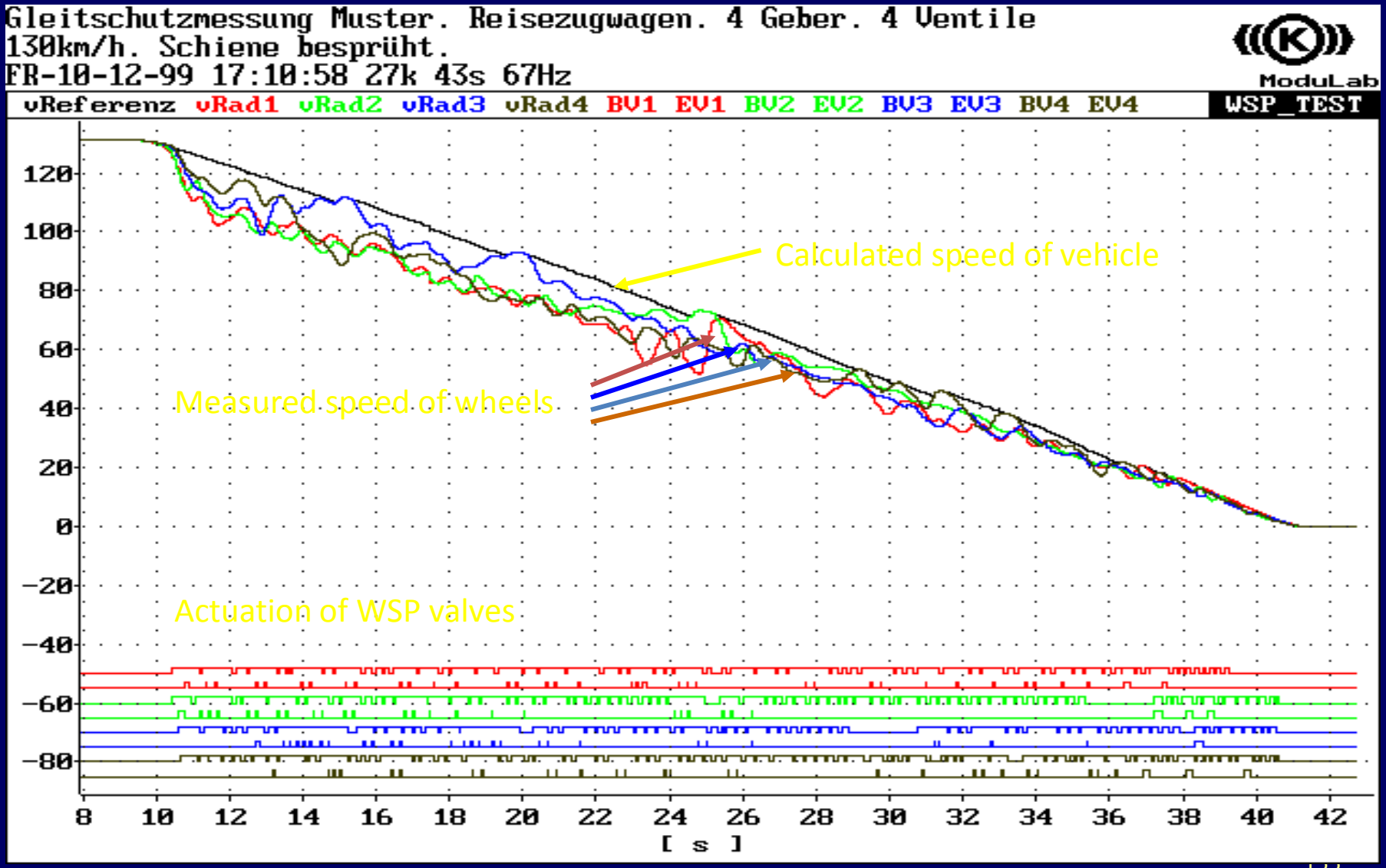
Pneumatic Assembly Control Logic

- Reduce BC pressure if
  - $Vi \leq V2$ or
  - $Ai \leq DEC$
- Restore BC pressure if
  - $Vi \geq V1$ or
  - $Ai \geq ACC$
- Maintain BC pressure if
  - $V2 \leq Vi \leq V1$ or
  - $DEC \leq Ai \leq ACC$

Control Logic Of Pneumatic Device



WSP - Field Test Data




Thank You