ADHESION CONTROL

Adhesion control is a locomotive function that deals with wheel slips. In some cases, zero slip (or minimal slip) is desired; in other cases, higher levels of slip are permitted. Regardless of approach, the "bottom line" of as wheel slip system is how much the locomotive can pull after wheel slips have been considered.

- Adhesion is the ratio of drawbar force to locomotive weight.
- The "dispatchable adhesion" is the overall adhesion rating
  - a measure of how much a locomotive can pull.
  - to determine how many locomotives will be necessary to pull a specific train over a specific section of railroad.

Adhesion Systems:

- Controlled-Creep - Radar Dependent,
- Back-up Wheel Slip - Non Radar,
- Starting (W/S) - Non Radar,

CONTROLLED CREEP SYSTEM

- It permits moderate levels of wheel slip which has the effect of actually increasing adhesion.

- For the system to function a true ground speed signal (radar) is required.

SLIP & CREEP

- Slip and creep are often used interchangeably.
- Slip is the additional speed that a wheel may have
- Creep is the slip level divided by the locomotive's speed
- For example, if the locomotive is moving at 12 KMPH and the wheel is turning at 13.2 KMPH, then there is 1.2 KMPH slip or 10% creep, therefore: 13.2 -12 = 1.2 slip level

$$\frac{1.2 \times 100}{12} = 10\% \text{ creep}$$

SLIP & CREEP

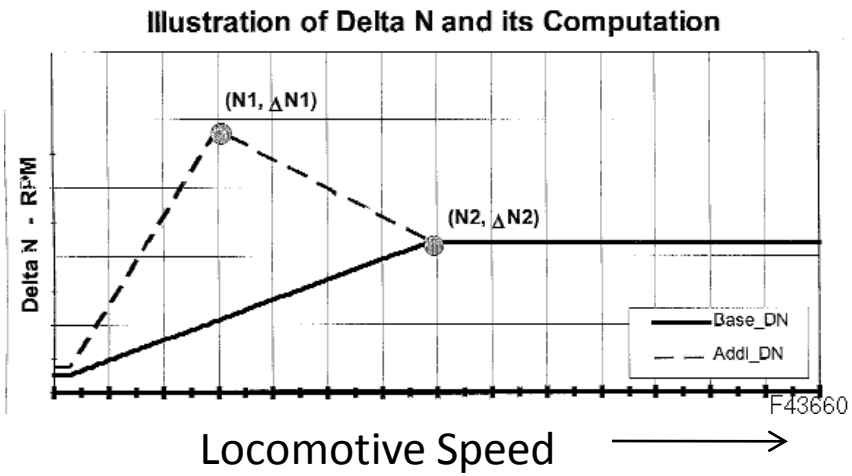
Wheel Slip	Description Status	Display Name
Idle Mode	**This mode is active when the locomotive is not in a loading Mode, i.e. Idle**	**IDLE**
System Starting	**This mode is active at low speeds, when there is not a reliable output from the radar. The radar typically active above about 1 MPH. The starting system will normally be active up to 1.5 MPH, and it may be active up to 3 MPH, under high adhesion conditions**	**1**
Controlled	**This is the creep mode known by most as "Super Series." This mode is more formally known as, "Controlled Creep" on AC locomotives. In this mode the Radar is used as a ground speed reference, and the traction motor wheel speed reference is controlled to allow the desired level of creep. The speed reference dN is sent to the traction inverters and the inverters reduce the torque output of the traction motors if the speed reference is exceeded.**	2
Backup System	**The traction inverters monitor the wheel speeds, primarily looking for high accelerations, and reduce the motor torque accordingly. The operation in the backup system is most obviously indicated by the, "N + dN" signals being at 3600 rpm.**	**3**

CONTROLLED-CREEP SYSTEM

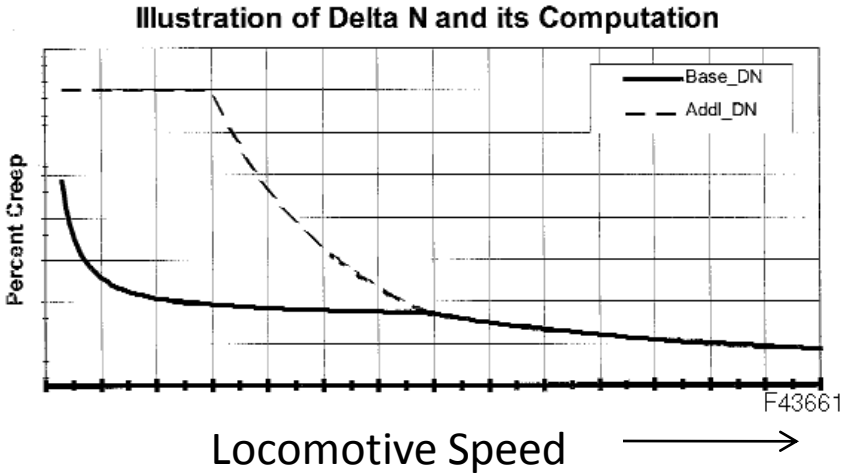
- During Power, Speed-Control, dynamic brake, blended brake, opposite direction brake, and rollback modes as long as all the proper feedback signals are present.
- involves computing wheel RPM limit (TxN+dN) signals and sending them to the appropriate inverter controller. The sign (value) of N+dN is positive when the locomotive is moving in the forward direction and negative when moving in the reverse direction. The magnitude of the N+dN should be greater when operating in “Power” and lower when operating in “Dynamic Brake” (approximately 4% max.).

dN & CREEP

Locomotive Speed - "Motor" RPM



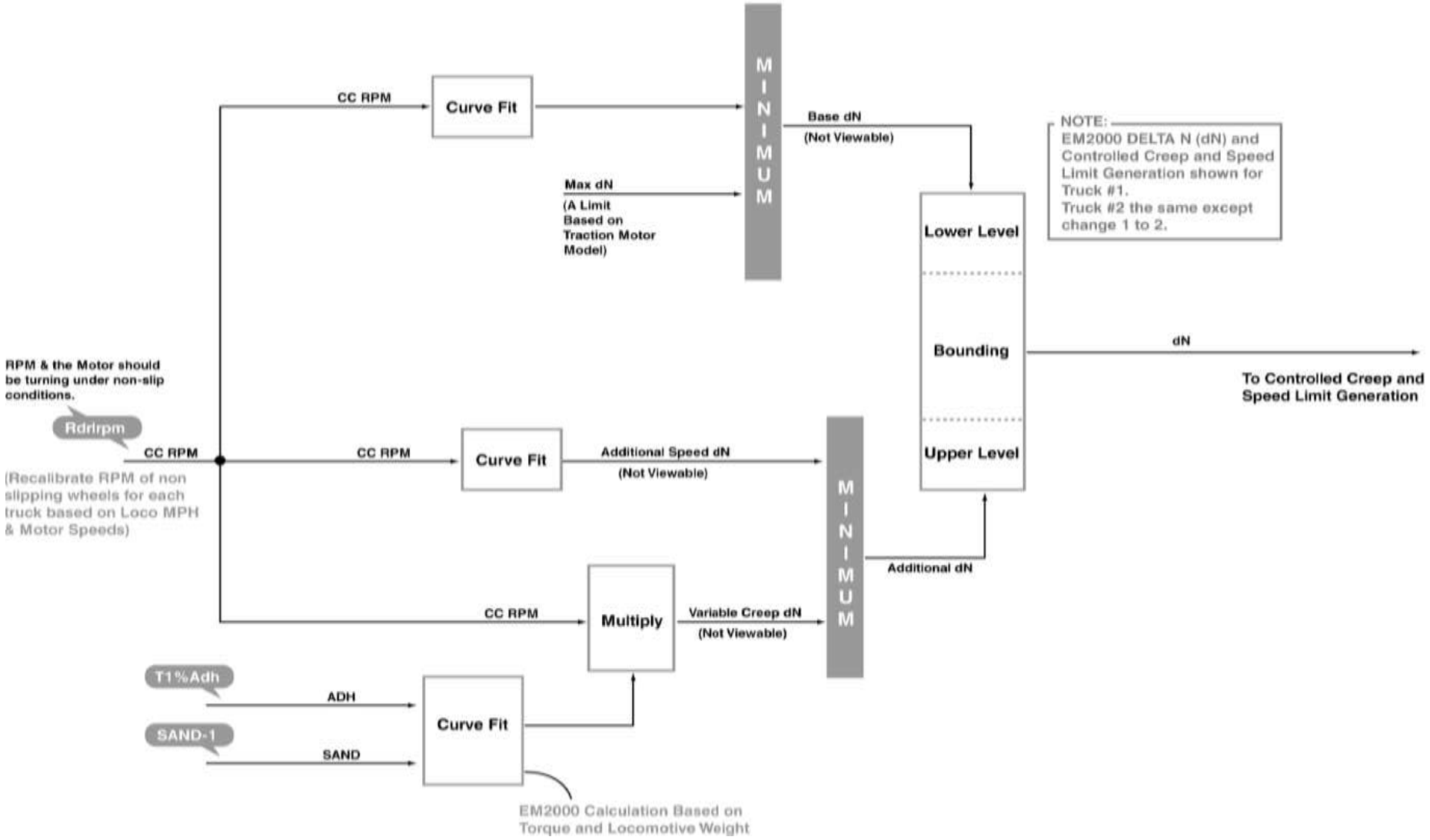
Creep Percentages versus Locomotive Speed.



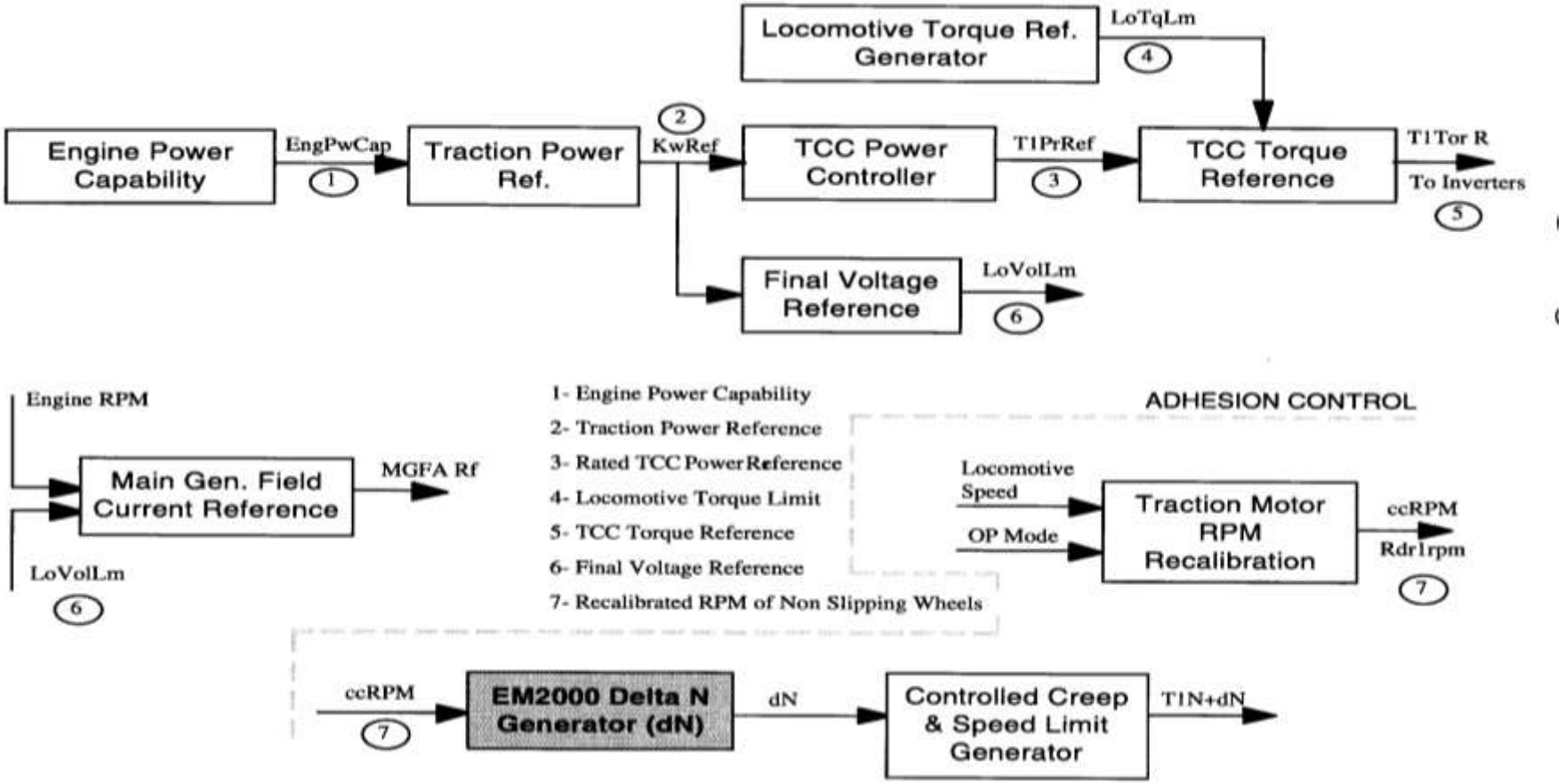
EM2000 DELTA N (dN) GENERATION

- Although wheel creep is expressed as a percentage, the control system works in absolute quantities. Hence, creep (slip) is expressed as an equivalent speed signal. To achieve this, the allowable slip is referenced to traction motor speed and appears in units of rpm.
- The dN value represents the amount of wheel slip the system will permit. In power, dN is positive and represents the amount of extra speed that will be permitted. In dynamic brake, dN is negative and represents how much the wheels are permitted to slow down. Minimum and maximum values are imposed for practical considerations.

EM2000 DELTA N (dN) GENERATION



LOAD CONTROL - EM2000 DELTA N (dN) GENERATION



CONTROLLED CREEP & SPEED LIMIT GENERATION

TRACKING dN

- The tracking dN signal provides the means for the creep level to change between the Base dN value and the Additional dN values. Essentially, this signal is set to be slightly higher than actual wheel speed. Hence, the name tracking is used. By placing the tracking dN value just above actual wheel speed, the wheels are free to turn faster.