Heavy Truck – DISC/S-CAM IV Air Brake

Overview: Computes and Simulates the deceleration of S-CAM or Air Disc (Power Shaft or Eccentric Lever) equipped vehicles based on Initial Speed or Distance and the setup and adjustments of the vehicles braking system. This module compensates for the heat created during the run. In Automatic ABS mode the instantaneous Chamber air pressure differential set by the user is maintained throughout the course of the run. This advanced feature is only available in REC-TEC Platinum.

The generation IV module is capable of changing many of the initial inputs during the course of the run including the surface friction, grade, air pressure, and sensor condition using a distance domain matrix. This capability allows the simulation of acceleration, deceleration and constant velocity at varying distances during the run.

Entry into Module:

This module of the program is normally entered by clicking on the **REC-TEC** block in the upper left of the **REC-TEC Window** causing the drop-down menu to appear. Place the cursor on the **Heavy Truck** block and click on **DISC/S-CAM Air Brake** on the sub-menu to initiate this module.

Under certain circumstances, the user may choose to use the **Files** block instead of the drop-down menu approach. Selecting any file with a **.TRK** extension in the **Dialog box** accessed from either the **Open Single File** or **Open Multiple Files** block opens this module.

Selecting **AutoLoad [ON]** from either the **Setup Menu** or the **AutoLoad Icon** on the upper right side (third line) of the **REC-TEC Window** automatically loads the two-vehicle scenario that was on the screen when the module was closed, either individually, or when the program was closed. With **AutoLoad [OFF]** on the main **REC-TEC Window,** modules will start without loading a file. Use **AutoLoad [OFF]** and manually load the file if only one vehicle is involved.

Data Entry:

This module contains the following data entry blocks:

S-Cam/Disc Air Brake

- **Surface Friction** – Measured
- **C/TTD –** Car Truck Tire Differential – adjustment to Surface Friction
- **Grade (Test) –** Grade at Friction Test Area – used to correct to level if Surface Friction not measured at Actual site
- **Grade (Actual) –** Grade at Area under scrutiny (Scene)

Compute for:

- **Initial Speed** – Solves for Initial Speed using input value for Distance (Iteration)
- **Distance** – Solves for Distance using input value for Initial Speed

Compute for Distance/Initial Speed – Command Button to initiate computations

- **Final Speed** – Final Speed of Vehicle in this run (multiple runs possible)
- **Steer Axles** – Number of Steer Axles
- **Drive Axles** – Number of Drive Axles
- **Trailer Axles** – Number of Trailer Axles
- **Temp** – Temperature of brakes at Start of (first) run (See Temperature note infra)
- **Air Press** – Air Pressure / User may elect to use 100(%) here and use actual Chamber Air Pressure for individual Wheels
- **Radio Button (#) =** Air Pressure Value **| Radio Button (%) =** Air Pressure Percent
- **ABS Press (A) – ABS Air Pressure Adjustment** – Subtracts **(#)** or Reduces **(%)** Input Value from Minimum Value Required to Lock

Brake Status

- **CS (Cold Stroke)** – Changes Display to show Cold Stroke Pushrod Force at the Static Start Temperature
- **DS (Dynamic Stroke)** – Changes Display to include Initial Dynamic Increment to Cold Stroke Pushrod Force at the Static Start Temperature

The following information list pertains to each axle end in the configuration:

- **A/S** – Axle Number / Side (Left/Right)
- **Type –** Chamber Type – Enter directly or select from **Chamber Type** (below)
- **ABS %** – Enter ABS% of Conventional Brake based on type/Cyclic rate
- **Lift** – Enter horizontal distance the power shaft travels in one complete revolution for Air Disc if not default
- **Psi(E)** – Enter as **Percent (%)** or **Actual Pressure** at Chamber. Dependent on entry for **Air Press** – this is opposite of **Air Press** entry. Entering a zero (**0**) or blanking out the entry turns the brake inoperable and it becomes freewheeling unless it is locked.
- **MaxP –** Enter **Maximum Pressure** available for this chamber. This **Maximum Pressure** is used in calculating **Automatic ABS** values.
- **Slk L** – Length of Slack Adjuster (measured)
- **f(L)** – Friction value of Brake Pad
- **PRc** – Pushrod Stroke (Cold - measured)
- **P Force** – Shows either the Cold Stroke Force at the Initial Static Temperature or the Stroke incremented for the Initial Dynamic Increment. (User Selectable)
- **Lock(<)** – Minimum Force required to Lock Brake for Load
- **r-P/D** – (Air Disc) distance from Center of Pad to Wheel Axis / Drum Radius

- **R-rad** – Rolling Radius of Wheel (measured Center to Surface)
- **Vload** – Vertical Load on Axle end

Many of the above columns have "radio buttons" that will populate all blocks in the column with the value inserted in block(1).

Check Boxes (New)

- **ABS Sensor Link between Axles (New) –** Links Brakes on Axles allowing one Sensor to control Multiple Axles. Right Sensor controls Right brakes and Left Sensor controls Left brakes.
- **ABS –** Checking this block configures Brake as ABS
- **Sensor –** Check block to set location of Sensor for controlling Brakes on Multiple Axles (Right or Left). If Sensor on a wheel is damaged or inactive, remove the check for non-working sensor
- **Air Disc (Lever)** – Configures Brake as Air Disc (Lever)
- **Air Disc (Power Shaft)** – Configures Brake as Air Disc (Power Shaft)
- **Lck** – Checkbox to Lock Wheel regardless of data entered
- **Automatic ABS Computations (New)** – Enables Automatic ABS Configurations for all Computations including recalibrations during Finite Difference Analysis. Manual Configuration can be set by un-checking the box. Manual settings will not change during FDA computations.
- **Auto-ABS** – Sets the precision for the program to use to key adjustments to the Air Pressure in each chamber based on the Pushrod Stroke length. Increasing the precision lengthens the computational time required to reach a solution.

Termination – Selection allows termination of run for multiple (Segmented by **Time** or **Distance** or **Speed**) runs or at **Collision Speed** as required.

- **Final Speed**
- **Time**
- **Distance**

Computation Increment – Sets the Time increment between computations during run. Accuracy increases as increment is shortened between "looks" at the status of all of the brakes in the system.

- **0.1 Seconds**
- **0.01 Seconds**
- **0.001 Seconds**
- **0.033 Seconds (Animation output)**

Output – The output from this module is divided into several different selectable options:

- **View Input Data** – Gray Command Button at bottom of main screen limits display to the input variables as entered

- **Compute for Distance/Initial Speed** – Green Command Button in leftmost frame initiates computations and displays Final Status of all brakes. The small vertical bar to the right of the Compute button will run the computations without engaging the Matrix data.

  Table Legend

  - **Wheel** – Axle Number / Side (Left/Right)
  - **Type –** Chamber Type
  - **Psi(E)** – **Percent (%)** or **Actual Pressure** at Chamber. Dependent on entry for **Air Press** – this is opposite of **Air Press** entry.
  - **Sl/Lm** – Length of Slack Adjuster (measured) or Air Disk (Lever Measured)
  - **Lift** – horizontal distance the power shaft travels in one complete revolution for Air Disc (Power Shaft) if not default (2.125)
  - **f(L)** – Friction value of Brake Pad
  - **PRc** – Pushrod Stroke (Cold - measured)
  - **T(I)** – Temperature Increase
  - **PRh** – Pushrod Stroke (Hot)
  - **D(I) –** Dynamic Increase
  - **PRd** – Pushrod Stroke (Dynamic)
  - **Force** – Pushrod Force
  - **r-P/D** – (Air Disc) distance from Center of Pad to Wheel Axis / Drum Radius
  - **R-rad** – Rolling Radius of Wheel (measured Center to Surface)
  - **Vload** – Vertical Load on Axle end
  - **%Tot –** Percent of Total
  - **Avl BF** – Available Brake Force corrected for grade
  - **Att BF** – Attempted Brake Force corrected for grade
  - **BForce** – Brake Force corrected for grade
  - **Eff** – Efficiency corrected for grade
  - **%Brk –** Braking(%) corrected for grade
  - **S** – Status: (L)ocked; (I)noperative; (F)ailed; (Ok) Working not Locked

- **Note:** Temperature (Start) – After testing and consultation with Ron Heusser, the following program settings are currently used within the program for determining the temperature increment during the course of the brake application. These settings allow the user to disable the temperature incrementing by setting a starting temperature below 70 degrees.

  - At temperatures below 70 degrees, the temperature increment is disabled
  - At temperatures between 70 and 300 degrees, the increment is linear
  - At temperatures above 300 degrees, the increase becomes non-linear and follows the formulae in the SAE paper #910126.

- **View Text File** – An output file is created for the time increment showing Time, Velocity, Distance and Braking (% based on 1). This output file is space-delimited and can be called into **Excel**® or used by animators.

- **Simulation** – Engages a Graphical Display of Brake Status and Deceleration Curve for Vehicle with Time (top) and Distance (bottom) scales. The display also contains running digital information on speeds, times and distances, which are stopped at the point of failure or at final values. The values are updated for the computation time increments selected. **[Esc]** to Exit. The small vertical bar to the right of the Simulation button will run the simulation without engaging the Matrix data.

- **Matrix Inputs –** Calls up a distance-domain based matrix allowing 15 separate interrupts during the simulation for changing the Surface Friction, Grade (Actual), Pressure (A), disabling the individual brakes by zeroing the air pressure in any chamber as well as disabling any of the individual ABS sensors. Setting the friction (and grade) to zero, allowing the vehicle to maintain a constant velocity. A negative value for friction (or grade) will accelerate the vehicle. In addition the user can now lock any of the brakes or can engage the Spring Brake at a selected wheel. Engaging a Spring Brake allows the user to set the Equivalent Air Pressure for the individual Spring Brake (usually the air pressure required to disengage the Spring Brake). These capabilities will allow the simulation to mimic most three-dimensional trajectories. Placing the cursor on the Wheel Designation next to a disabled checkbox for a particular mode will give information on the Interrupt Distance and, in the case of a Spring Brake, will display the Equivalent Air Pressure.

- **Matrix Maneuvers –** The Matrix provides the user with the ability to "coast" with either a user selectable deceleration, or with no deceleration by modifying the drag factor (Mu) value at any distance interrupt during the run. Using a Mu value greater than zero (0) will cause the vehicle to decelerate provided at least one of the brakes is decelerating enough to overcome any downhill grade. A zero (0) value will cause speed changes dependent on grade only.

  The Matrix will also allow any activated Spring Brakes to control the deceleration of the vehicle if no other braking is engaged. In order to set this up, the Mu should be set to the proper value and at least one of the Spring Brakes must be engaged. The user may then select an Air Pressure [Air(P)] value of zero (0) at the appropriate interrupt. Multiple interrupts may be set to zero(0) with changes made to different settings at the different interrupt points to simulate the conditions of the maneuver in question. The user is advised to meticulously check all changes to insure that they are not antagonistic or self-canceling. The program uses an elaborate hierarchy to prioritize the settings. Care should be exercised to insure that the answers generated are consistent with what could be reasonably expected to occur during the maneuver. Exotic/multiple failures

should be given wide ranges absent collateral proof of the accuracy of the computations.

- **Matrix Color Legend** – Left side wheels are Green and Right side wheels are Red. Wheels color-coded Blue are modified in the Matrix for the particular Mode (PSI, Sen, Lock, or S-Brk) selected by the User. Wheels color-coded Black are set that way on the main interface.

  Color Legend:
  - **Yellow** = Locked
  - **Purple =** Spring Brake only
  - **Green** = Operable – not locked
  - **Red** = Failed
  - **Orange** = Braking not able to overcome grade
  - **Pink** = Inoperable
  - **Dark Blue** = ABS Air Disk (sensor)
  - **Light Blue** = ABS Air Disc (no sensor or slaved)
  - **Dark Gray** = ABS S-Cam (sensor)
  - **Light Gray** = ABS S-Cam (no sensor or slaved)

Options:

Several **Command Buttons** appear in a frame located at the lower right corner of the module Window. The **Command Buttons** allow the user to engage options including the option to **Open** and **Save** the data (for **Vehicle 1** and **Vehicle 2**) required to generate the scenario shown on the screen at the time the file was saved.

- **Open .TRK File –** Calls up a **Dialog box**, which **Opens** any pre-existing **.TRK** file and displays the output results.

- **Save .TRK File –** Calls up a **Dialog box**, which **Saves** data on the screen to files with any user-selectable filenames. This is independent of the automatic saving as "**LastFile.TRK**" of the data at the close of this module or the close of the program.

- **Force Chart –** Shows the current Force Chart values (Identical to the imbedded values in the program), which have been reviewed and updated by Ron Heusser. These are not the same values as used in his SAE paper #910126 "Heavy Truck Deceleration Rates as a Function of Brake Adjustment" Ronald B. Heusser, NTSB. This module is based on the principles set forth in that paper with all modifications requested or approved by Ron Heusser including the upgrade to the 2008 values and the 2008 modifications to the brake force formulae.

- **Segmented Run (Next)** – Running the program with a non-zero **Final Speed** or a **Time** or **Distance** that results in a non-zero **Final Speed**, enables this **Command Button**. Selecting **Segmented Run** brings up a Dialog box for saving the current scenario as a uniquely named file. The module then reconfigures for the next

Segment of the run. This process will continue until a Final Speed of zero (0) is reached. At the completion of the run to a Final Speed of zero (0), the user must manually save the last segment.

- **N** – This button toggles a graphical number pad on the screen that can be used to enter data into the input boxes without using your keyboard number pad. This may be useful for presentations as data entry can be accomplished using a wired/wireless mouse.

- **FD Analysis** – Calls up a frame that permits the user to input the minimum and maximum values for selected input variables. The resulting analysis computes the uncertainty level for the specified range of the input variables.

  For a more in-depth description of **Finite Difference Analysis**, see the Finite Difference Analysis Section of this Manual – Press **[F2]** from any Active module of the program.