

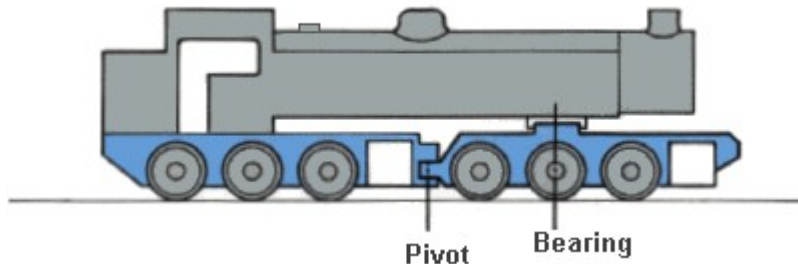
# Recommended Parameters for Articulated Steam Locomotives in Open Rails

By Sanjay Das—07/08/23

## Introduction

In the interest of breaking the mold of the constraints established by Microsoft Train Simulator, there is interest in improving articulated locomotives so that they are one-piece models, eliminating the need to have multiple shape and engine files for each section of the locomotive. ORTS' higher limits in the number of wheels and bogies (trucks) a shape file can have is a vast improvement. The Challenger test model that I have built proves that the bits and pieces are all there, but there is still some work that needs to be done to fill in the gaps. The most recent unstable release of ORTS allows a single steam locomotive to have multiple “engines” (cylinders, drive wheels, etc.), so now all that needs to be done is to create parameters defining the articulation of the locomotive. Here are some recommendations for new physics parameters specifically for articulated locomotives.

While articulated locomotives are not all the same, the most common method of articulation in the United States is the Mallet method (Illustration 1), in which there are two sections, one of which is fixed to the boiler and the other made to be flexible. Since it is the most familiar to people in the United States, these parameters were initially written with the Mallet articulation method in mind. However, these parameters can be potentially adapted or improved upon for other methods of articulation which are more often seen outside the United States (Meyer, Garratt, Fairlie, etc.).



*Illustration 1: Mallet method of articulation showing pivoted front unit and rear unit rigidly affixed to boiler. Image by Douglas Self from Loco Locomotives website.*

## Defining Articulation

With an articulated locomotive, it sometimes becomes necessary to define, if not clarify, whether each chassis section associated with each group of driving wheels is fixed or flexible (relative to the boiler), to avoid ambiguity in certain situations. This is done with the following parameter:

**ORTSArticulationType ( x )**

In this case, “( x )” represents one of two labels:

**( Fixed )**--This label reminds ORTS that the associated driving wheels are parented to “MAIN” on the shape file. Most commonly used for the rear unit of Mallet type locomotives, where the boiler is

attached to, or

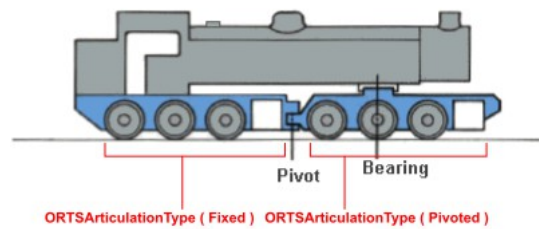
( **Pivoted** )--This label reminds ORTS that the associated driving wheels are parented to a BOGIE instead of MAIN, and as such will “pivot” with the Bogie. Most commonly used for the front unit of Mallet type locomotives.

A Mallet-type locomotive would be notated as:

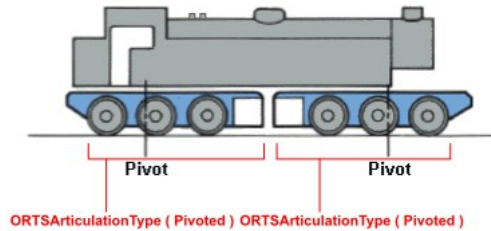
```
ORTSSteamEngines ( 2
  Comment ( ** Front Engine Unit ** )
  Steam (
    ORTSArticulationType ( Pivoted )
    Comment ( ** Other Front Engine Parameters Go Here ** )
  )
  Comment ( ** Rear Engine Unit ** )
  Steam (
    ORTSArticulationType ( Fixed )
    Comment ( ** Other Rear Engine Parameters Go Here ** )
  )
)
```

Examples of three common methods of steam locomotive articulation and how they would be notated in ORTS are shown in Illustration 2.

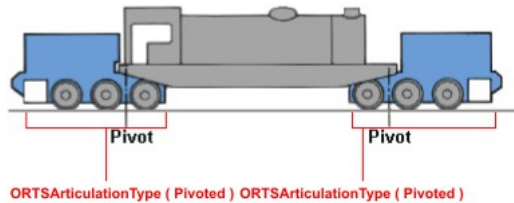
## MALLET



## MEYER



## GARRATT



*Illustration 2: Three methods of steam locomotive articulation and their associated ORTS ArticulationType parameters. Base images by Douglas Self from Loco Locomotives website.*

## Clarifying Hierarchies

For the most part, ORTS is capable of assuming the relationship between the groups of driving wheels by looking at the shape file hierarchy, there needs to be a way to avoid ambiguity in certain situations. Therefore, the following optional parameter can be added:

### ORTS ArticulationAnimation ( “x” )

In this case, “( x )” represents the name of the sub-object that the group of driving wheels is parented to, as it appears within the shape file hierarchy and matrix. Its function is equivalent in function to the **Animation** parameter in a route's *turntables.dat* file, and it is completely optional, but if it is specified for **one group**, it **must be defined for all other groups as well**. A Mallet-type locomotive would be thus defined:

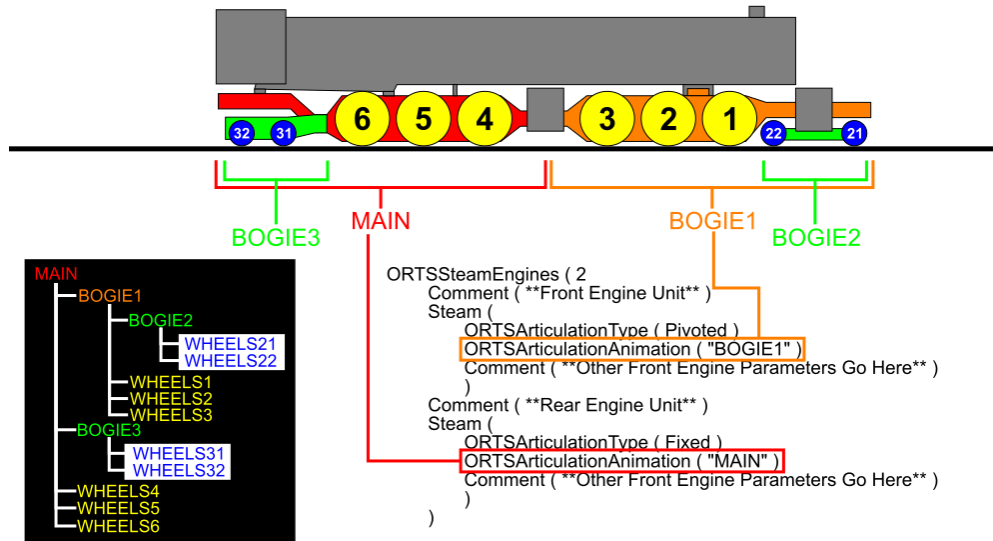
```
ORTS SteamEngines ( 2
  Comment ( ** Front Engine Unit ** )
  Steam (
    ORTS ArticulationType ( Pivoted )
    ORTS ArticulationAnimation ( “BOGIE1” )
```

```

        Comment ( ** Other Front Engine Parameters Go Here ** )
    )
    Comment ( ** Rear Engine Unit ** )
    Steam (
        ORTSArticulationType ( Fixed )
        ORTSArticulationAnimation ( "MAIN" )
        Comment ( ** Other Rear Engine Parameters Go Here ** )
    )
)

```

An example of a 4-6-6-4 “Challenger” locomotive, as a one-piece model, utilizing the **ORTSArticulationAnimation** parameter is shown below in Illustration 3.



*Illustration 3: Demonstration of Clarifying driving wheel groups on one-piece articulated locomotive with ORTSArticulationAnimation parameter..*

The **ORTSArticulationAnimation** parameter could also make it possible to adapt existing multi-section articulated locomotive models so that they can be given proper parameters under the control of a single \*.eng file. This can potentially be done by substituting the appropriate shape (\*.s) files in place of a shape file hierarchical label, provided the **WagonShape** parameter in the Wagon section of the \*.eng file is omitted.:

```

ORTSSteamEngines ( 2
  Comment ( ** Front Engine Unit ** )
  Steam (
    ORTSArticulationType ( Pivoted )
    ORTSArticulationAnimation ( "fronteng.s" )
    Comment ( ** Other Front Engine Parameters Go Here ** )
  )
)
Comment ( ** Rear Engine Unit ** )

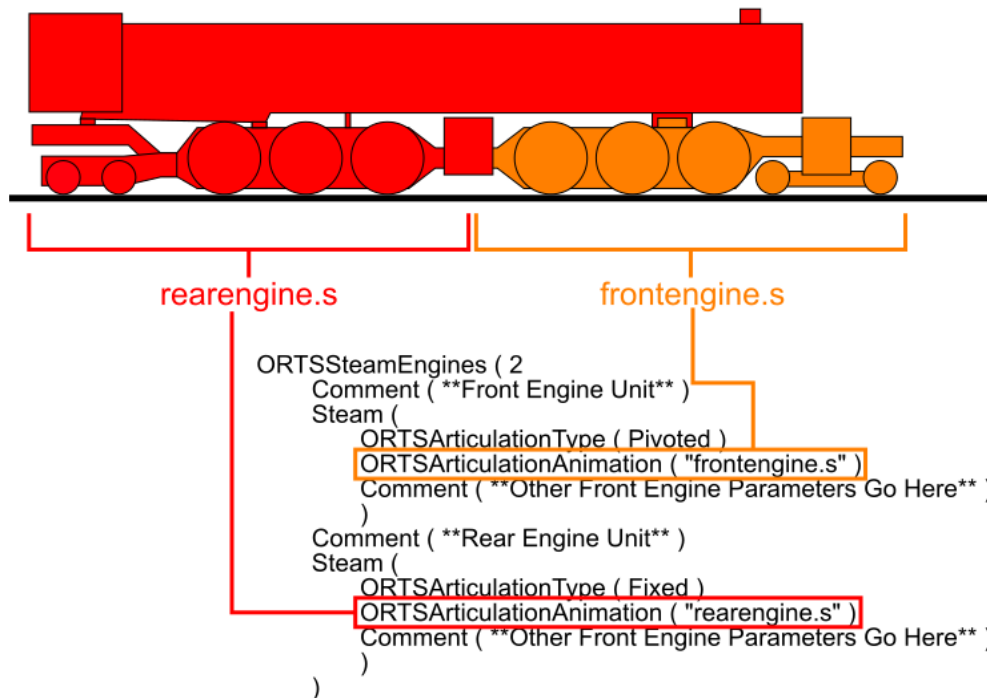
```

```

Steam (
  ORTSArticulationType ( Fixed )
  ORTSArticulationAnimation ( "reareng.s" )
  Comment ( ** Other Rear Engine Parameters Go Here ** )
)
)

```

An example of a 4-6-6-4 “Challenger” locomotive utilizing the **ORTSArticulationAnimation** parameter to combine two separate shape files into the control of a single \*.eng file is shown in Illustration 4.



*Illustration 4: Demonstration of using ORTSArticulationAnimation to join two shape files of a two-piece articulated locomotive so they are under the control of a single \*.eng file.*

## Defining Angle Constraints for Pivoted Driving Wheel Groups

It cannot be denied that an articulated locomotive has more physical flexibility than a rigid-frame locomotive does. However, this flexibility is constrained to some degree based on the geometry of parts such as the chassis hinge pin, boiler bearings, centering devices, jointed steam pipes, etc. Exceeding these limits can potentially cause the locomotive to bind up or derail, especially when navigating a tight-radius curve. To simulate this, and preserve the visual integrity of the shape files (so for example, the jointed steam pipes don't appear to “break” when going around a tight curve), then the following parameter should be used:

**ORTSArticulationMaxAngle ( MinX MaxX MinY MaxY MinZ MaxZ )**

This parameter defines the rotational limits of the driving wheel group's associated chassis section

(BOGIE), in degrees, along the X, Y and Z axes. Much like the “**Azimuth ( )**” and “**Elevation ( )**” parameters in the lighting sections, the “minimum” value is usually a negative number and the “maximum” is usually positive. It is used in conjunction with the pre-existing derail coefficient and curve resistance parameters to determine the likelihood of the locomotive binding up or derailing when the rotation, on any axis, is anything other than zero. Theoretically, if these limits are exceeded, then the locomotive would derail.

This parameter is only needed when the **ORTSArticulationType** parameter for the associated driving wheel group is set to ( **Pivoted** ). It is not needed if the parameter is set to ( **Fixed** ).:

```
ORTSSteamEngines ( 2
    Comment ( ** Front Engine Unit ** )
    Steam (
        ORTSArticulationType ( Pivoted )
        ORTSArticulationAnimation ( “BOGIE1” )
        ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )
        Comment ( ** Other Front Engine Parameters Go Here ** )
    )
    Comment ( ** Rear Engine Unit ** )
    Steam (
        ORTSArticulationType ( Fixed )
        ORTSArticulationAnimation ( “MAIN” )
        Comment ( ** Other Rear Engine Parameters Go Here ** )
    )
)
```

## Rigid Wheelbases for Each Group

In most cases, the rigid wheelbases of each driving wheel group are identical, as both groups usually have the same number of driving wheels. Therefore, the **ORTSRigidWheelBase** parameter can be defined in the wagon section of an engine file, as it has been up until now.

However, it is sometimes desirable to define separate **ORTSRigidWheelBase** parameters for each engine on the locomotive. Examples include wheel arrangements where the number of driving wheels for each engine are not equal (ex: 2-6-8-0), or to avoid ambiguity in certain situations.

Therefore, instead of the **ORTSRigidWheelbase** parameter being located within the Wagon section of the \*.eng file, the **ORTSRigidWheelbase** parameter **MUST be located inside the grouping**, and **MUST be repeated for each grouping**, even if the values for both (or all) groupings are the same.:

```
Comment ( ** Example Rigid Wheelbase Code for Articulated Locomotive ** )
Wagon ( Loco_Name
    Comment ( ** Additional Parameters Go Here ** )
)
Engine ( Loco_Name
    Comment ( ** Additional Parameters Go Here ** )
    ORTSSteamEngines ( 2
        Comment ( ** Front Engine Unit ** )
        Steam (
            ORTSArticulationType ( Pivoted )
            ORTSArticulationAnimation ( “BOGIE1” )
            ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )
```

```

        ORTSRigidWheelBase ( 12ft 4in )
        Comment ( ** Other Front Engine Parameters Go Here ** )
    )
    Comment ( ** Rear Engine Unit ** )
    Steam (
        ORTSArticulationType ( Fixed )
        ORTSArticulationAnimation ( "MAIN" )
        ORTSRigidWheelBase ( 12ft 4in )
        Comment ( ** Other Rear Engine Parameters Go Here ** )
    )
)
Comment ( ** Additional Parameters Go Here ** )
)

```

Although the above example has the same value for both groupings, the **ORTSRigidWheelbase** parameter is still mandatory for each grouping. However, oddball wheel arrangements, like 2-6-8-0 and 4-4-6-2, will obviously have different values for each grouping, like this:

```

Comment ( ** Example Rigid Wheelbase Code for AT&SF 4-4-6-2 Mallet Locomotive ** )
Wagon ( ATSF 1300
    Comment ( ** Additional Parameters Go Here ** )
)
Engine ( ATSF 1300
    Comment ( ** Additional Parameters Go Here ** )
    ORTSSteamEngines ( 2
        Comment ( ** Front Engine Unit ** )
        Steam (
            ORTSArticulationType ( Pivoted )
            ORTSArticulationAnimation ( "BOGIE1" )
            ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )
            ORTSRigidWheelBase ( 6ft 1in )
            Comment ( ** Other Front Engine Parameters Go Here ** )
        )
        Comment ( ** Rear Engine Unit ** )
        Steam (
            ORTSArticulationType ( Fixed )
            ORTSArticulationAnimation ( "MAIN" )
            ORTSRigidWheelBase ( 12ft 2in )
            Comment ( ** Other Rear Engine Parameters Go Here ** )
        )
    )
)
Comment ( ** Additional Parameters Go Here ** )
)

```

## Separate Weights for Each Group of Driving Wheels

The **ORTSDriveWheelWeight** parameter may be located either inside or outside the grouping.:

- If locomotives specifications dictate **only one** “weight on driving wheels” value, implying that the weight value is **distributed evenly among all groups**, the **ORTSDriveWheelWeight**

parameter can be placed **outside the groupings**. ORTS will then take this value and divide it among the number of groupings to find the weight on each group.

- If on the other hand, the individual weight values for **each** driving wheel group are available, then one **ORTSDriveWheelWeight** parameter can be placed **within** each grouping. This can be useful for modeling situations where the weight distribution between the groupings is uneven.

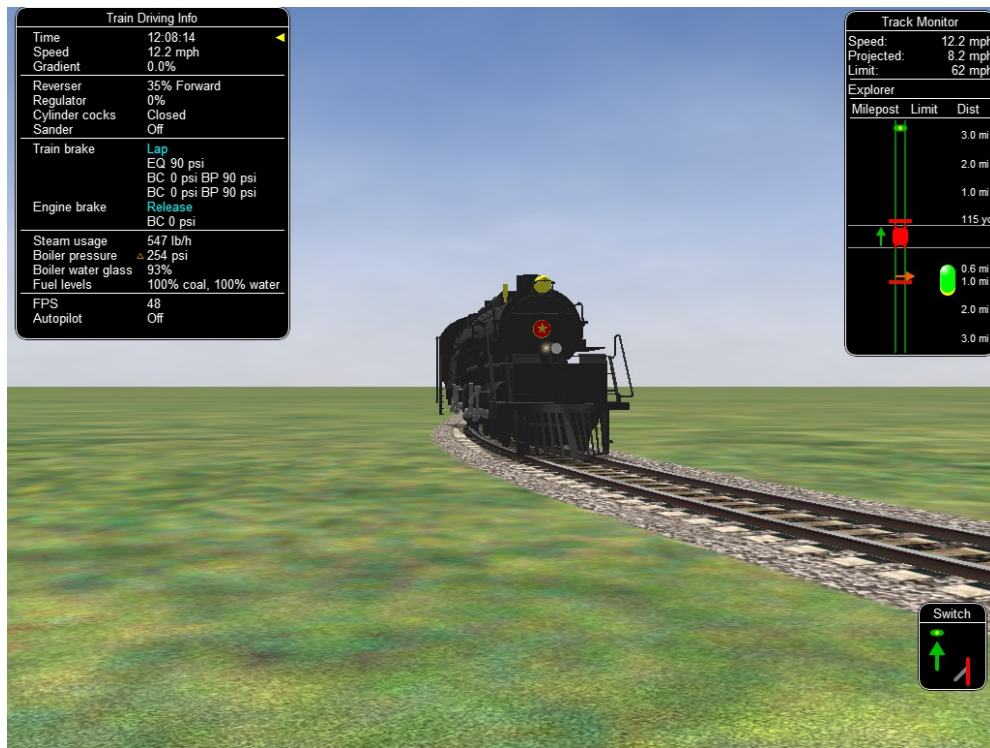
## Registration of Emitters and Auxiliary Shapes to Flexible Chassis Sections

Currently, ORTS assumes that any lighting emitters, smoke and steam emitters, coupler and air hose shapes and freight animation shapes associated with a locomotive are “attached” to the “MAIN” object in the shape file's hierarchy. However, as we move toward modelling articulated locomotives as one-piece models, this “MAIN” method of registration does not work in all cases, particularly for lights, effects and auxiliary shapes that would ordinarily be “attached” to a flexible section of the locomotive chassis, which is often treated as a “BOGIE”. So in those cases there needs to be a way to tell ORTS that any light, FX, or auxiliary shape is to register to a BOGIE instead of MAIN.

For example, it is a fairly common practice on articulated locomotives to mount the headlight on a high point on the pilot deck of the pivoting front engine unit, instead of on the smokebox like on a rigid-frame locomotive. When an articulated locomotive goes around a curve, the front engine unit will enter the curve, and thus begin to pivot laterally, before the boiler and rear engine unit enter the curve. Therefore, the advantage to the front engine mounting arrangement for the headlight is that a greater percentage of the track immediately ahead of the locomotive is illuminated than if it were mounted on the smokebox.

Let's assume you have an articulated locomotive that is a one-piece model. The physical headlight on the model is attached to the front engine unit, which you have labeled as BOGIE1 so it pivots laterally when the locomotive goes around a curve. If, for ORTS, you were to code the headlight emitters (both cone and glow) like you ordinarily would, then the emitters would align perfectly when the locomotive is on tangent track. However, once the locomotive enters a curve, the front engine begins to pivot as it should, and the physical headlight on the model remains attached to it, but the headlight's associated emitters remain in place (as illustrated with my experimental 4-6-6-4 “Challenger” model in Illustration 5) until the boiler and rear engine begin “rounding the curve”. This is because ORTS is still registering the headlight's emitters to “MAIN” and therefore those emitters are “attached” to the boiler and rear engine and not the front one.





*Illustration 5: Experimental one-piece 4-6-6-4 "Challenger" model in ORTS going around a curve, clearly illustrating the need for a means of "attaching" light emitters to parts of a model besides "MAIN".*

I propose two possible solutions to this problem. The first involves relocating the lighting emitter information so that it is within the driving wheel grouping instead of the Wagon section of the .eng file:

Comment ( \*\* Example Code for Attaching Lights to Front Engine Unit of Mallet Articulated \*\* )

Wagon ( Loco\_Name

Comment ( \*\* Additional Parameters Go Here \*\* )

)

Engine ( Loco\_Name

Comment ( \*\* Additional Parameters Go Here \*\* )

ORTSSteamEngines ( 2

Comment ( \*\* Front Engine Unit \*\* )

Steam (

ORTSArticulationType ( Pivoted )

ORTSArticulationAnimation ( "BOGIE1" )

ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )

ORTSRigidWheelBase ( 12ft 4in )

Lights ( 2

Light

(

comment( Cone of Headlight—Front Engine Mount )

Type ( 1 )

Conditions (

Headlight ( 3 )

Service ( 2 )

Unit ( 2 )

```

        Control ( 2 )
    )
    Cycle ( 0 )
    FadeIn ( 0.5 )
    FadeOut ( 0.5 )
    States ( 1
        State
        (
            Duration ( 0.0 )
            LightColour ( fffe3b5 )
            Position ( 0 2.64976 9.426 )
            Transition ( 0 )
            Radius ( 1000.0 )
            Angle ( 22.5 )
        )
    )
)
Light
(
    comment( Headlight—Front Engine Mount )
    Type ( 0 )
    Conditions (
        Headlight ( 3 )
        Service ( 2 )
        Unit ( 2 )
        Control ( 2 )
    )
    FadeIn ( 0.5 )
    FadeOut ( 0.5 )
    Cycle ( 0 )
    States ( 1
        State
        (
            Duration ( 0.0 )
            LightColour ( fffe3b5 )
            Position ( 0 2.64976 9.7473 )
            Azimuth ( 0 0 0 )
            Transition ( 0 )
            Radius ( 0.4 )
        )
    )
)
)
Comment ( ** Other Front Engine Parameters Go Here ** )
)
Comment ( ** Rear Engine Unit ** )
Steam (
    ORTSArticulationType ( Fixed )
    ORTSArticulationAnimation ( “MAIN” )

```

The same can be done for smoke and steam emitters, as well as shape files for coupler, air hose and freight animations:

```
Wagon ( Loco_Name
        Comment ( ** Additional Parameters Go Here ** )
)
```

```

Engine ( Loco_Name
Comment ( ** Additional Parameters Go Here ** )
ORTSSteamEngines ( 2
    Comment ( ** Front Engine Unit ** )
    Steam (
        ORTSArticulationType ( Pivoted )
        ORTSArticulationAnimation ( “BOGIE1” )
        ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )
        ORTSRigidWheelBase ( 12ft 4in )
        Lights ( 2
            Light
            (
                comment( Cone of Headlight—Front Engine Mount )
                Type ( 1 )
                Conditions (
                    Headlight ( 3 )
                    Service ( 2 )
                    Unit ( 2 )
                    Control ( 2 )
                )
                Cycle ( 0 )
                FadeIn ( 0.5 )
                FadeOut ( 0.5 )
                States ( 1
                    State
                    (
                        Duration ( 0.0 )
                        LightColour ( fffe3b5 )
                        Position ( 0 2.64976 9.426 )
                        Transition ( 0 )
                        Radius ( 1000.0 )
                        Angle ( 22.5 )
                    )
                )
            )
        )
    )
)

```

```

    )
Light
(
    comment( Headlight—Front Engine Mount )
    Type ( 0 )
    Conditions (
        Headlight ( 3 )
        Service ( 2 )
        Unit ( 2 )
        Control ( 2 )
    )
    FadeIn ( 0.5 )
    FadeOut      ( 0.5 )
    Cycle ( 0 )
    States ( 1
        State
        (
            Duration ( 0.0 )
            LightColour ( fffe3b5 )
            Position ( 0 2.64976 9.7473 )
            Azimuth ( 0 0 0 )
            Transition ( 0 )
            Radius ( 0.4 )
        )
    )
)
)
Effects
(
    SteamSpecialEffects
    (
        Comment ( Cylinder Cocks--Engineer's Side Front )
        Cylinders21FX
        (
            0.8 0.4546 7.4236
            1 0 0
            0.04
        )
        Cylinders22FX
        (
            0.8 0.4546 8.4236
            1 0 0
            0.04
        )
        Comment ( Cylinder Cocks--Fireman's Side Front )
        Cylinders11FX
        (
            -0.8 0.4546 7.4236
            -1 0 0

```

```

        0.04
    )
    Cylinders12FX
    (
        -0.8 0.4546 8.4236
        -1 0 0
        0.04
    )
)
FrontCouplerAnim ( frontcouplerclosed.s 0 0.75 0 )
FrontCouplerOpenAnim ( frontcoupleropen.s 0 0.75 0 )
FrontAirHoseAnim ( fronthoseconn.s 0.5 0.75 0 )
FrontAirHoseDisconnectedAnim ( fronthosedisconn.s 0.5 0.75 0 )
Coupling (
    Type ( Automatic )
    Spring (
        ORTSTensionStiffness ( 200000lbf 550000lbf )
        ORTSTensionR0 ( 0in 1.0in )
        ORTSTensionSlack ( 1.5in 1.0in )
        ORTSCompressionStiffness ( 200000lbf 550000lbf )
        ORTSCompressionR0 ( 0in 1.0in )
        ORTSCompressionSlack ( 1.5in 1.0in )
        ORTSBreak ( 1.8e6N 550000lbf )
    )
    Velocity ( 0.2m/s )
)
Comment ( ** Other Front Engine Parameters Go Here ** )
)
Comment ( ** Rear Engine Unit ** )
Steam (
    ORTSArticulationType ( Fixed )
    ORTSArticulationAnimation ( "MAIN" )
    ORTSRigidWheelBase ( 12ft 4in )
    Comment ( ** Other Rear Engine Parameters Go Here ** )
)
)
Comment ( ** Additional Parameters Go Here ** )
)

```

It also should be noted that any emitters and shape files that appear **outside** the grouping will always be **“attached” to “MAIN.”**

The second solution would be to keep the lighting, smoke and steam emitters and the coupler, air hose and freight animation information in their current positions outside the grouping, but add the following parameter would be into the emitter or coupler/air hose/freight animation code:

**ORTSRegistration ( “x” )**

This parameter is used to tell ORTS that the emitter in question is to be registered to an object other than “MAIN”, and the name of this object (as listed in the shape file hierarchy and matrix) is used as the variable. Its function is equivalent in function to the **ORTSArticulationAnimation** parameter described earlier. For example, to register the headlight emitter to the front engine unit, which is labeled “BOGIE1” (see Illustration 3), then you would set this as **ORTSRegistration ( “BOGIE1” )**. Or, in the case of a multi-piece model, use the shape file name (see Illustration 4) in the **ORTSRegistration** parameter (Example: **ORTSRegistration ( “fronteng.s” )**). Here's how it looks within the context of the lighting section of the engine file:

## Lights

```
( 2
Light
(
comment( Cone of Headlight—Front Engine Mount )
Type ( 1 )
Conditions (
    Headlight ( 3 )
    Service ( 2 )
    Unit ( 2 )
    Control ( 2 )
)
ORTSRegistration ( “BOGIE1” )
Cycle ( 0 )
FadeIn ( 0.5 )
FadeOut ( 0.5 )
States ( 1
    State
    (
        Duration ( 0.0 )
        LightColour ( fffe3b5 )
        Position ( 0 2.64976 9.426 )
        Transition ( 0 )
        Radius ( 1000.0 )
        Angle ( 22.5 )
    )
)
)
Light
(
comment( Headlight—Front Engine Mount )
Type ( 0 )
Conditions (
    Headlight ( 3 )
    Service ( 2 )
    Unit ( 2 )
    Control ( 2 )
)
ORTSRegistration ( “BOGIE1” )
FadeIn ( 0.5 )
```

```

    FadeOut      ( 0.5 )
    Cycle ( 0 )
    States ( 1
        State
        (
            Duration ( 0.0 )
            LightColour ( fffe3b5 )
            Position ( 0 2.64976 9.7473 )
            Azimuth ( 0 0 0 )
            Transition ( 0 )
            Radius ( 0.4 )
        )
    )
)

```

The **ORTSRegistration** parameter can also be used for smoke and steam emitters, such as the cylinder cocks for the front engine cylinders:

```

Comment ( Cylinder Cocks--Engine's Side Front )
Cylinders21FX
(
    0.8 0.4546 7.4236
    1 0 0
    0.04
    ORTSRegistration ( "BOGIE1" )
)
Cylinders22FX
(
    0.8 0.4546 8.4236
    1 0 0
    0.04
    ORTSRegistration ( "BOGIE1" )
)
Comment ( Cylinder Cocks--Fireman's Side Front )
Cylinders11FX
(
    -0.8 0.4546 7.4236
    -1 0 0
    0.04
    ORTSRegistration ( "BOGIE1" )
)
Cylinders12FX
(
    -0.8 0.4546 8.4236
    -1 0 0
    0.04
    ORTSRegistration ( "BOGIE1" )
)
Comment ( Cylinder Cocks--Engine's Side Rear )

```

```

Cylinders41FX
(
    0.8 0.48673 -0.51965
    1 0 0
    0.04
)
Cylinders42FX
(
    0.8 0.48673 0.48035
    1 0 0
    0.04
)
Comment ( Cylinder Cocks--Fireman's Side Rear )
Cylinders31FX
(
    -0.8 0.48673 -0.51965
    -1 0 0
    0.04
)
Cylinders32FX
(
    -0.8 0.48673 0.48035
    -1 0 0
    0.04
)

```

No **ORTSRegistration** parameter is needed for the rear engine cylinder cocks as the rear engine is labeled MAIN.

Here's how the **ORTSRegistration** parameter can be used to register a front coupler and air hose animation shape file to the front engine unit:

```

FrontCouplerAnim ( cplrfntclosed.s 0 1 12.06
ORTSRegistration ( "BOGIE1" )
)
FrontCouplerOpenAnim ( cplrfntopen.s 0 1 12.06
ORTSRegistration ( "BOGIE1" )
)
FrontAirHoseAnim ( hosefrontconn.s -0.2 0.66 12.06
ORTSRegistration ( "BOGIE1" )
)
FrontAirHoseDisconnectedAnim ( hosefrontdisconn.s -0.2 0.66 12.06
ORTSRegistration ( "BOGIE1" )
)

```

On a side note: Yes, I am well aware that coupler and air hose animation shapes are mutually exclusive at the moment, but this is just illustrative of how the new parameter can be used.

## Prototype Example Codes



Here's a sampling of potential codes using the parameters described in this document (excluding **ORTSRegistration**) based on real-world prototypes:

Comment (\*\* Example 1 -- Union Pacific Big Boy \*\*)

Wagon ( Union Pacific Big Boy

[ ... ]

CentreOfGravity ( 0m 2m 0m )

ORTSTrackGauge ( 4ft 8.5in )

ORTSUnbalancedSuperelevation ( 6in )

[ ... ]

)

Engine ( Union Pacific Big Boy

Type ( Steam )

ORTSSteamLocomotiveType ( Simple )

ORTSSteamEngines ( 2

    Comment (\*\* Front Engine Unit \*\*)

    Steam (

        ORTSArticulationType ( Pivoted )

        ORTSArticulationAnimation ( “BOGIE1” )

        ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )

        ORTSRigidWheelBase ( 18.0ft 3.0in )

        WheelRadius ( 34in )

        ORTSNumberDriveAxles ( 4 )

        NumCylinders ( 2 )

        CylinderStroke ( 32in )

        CylinderDiameter ( 23.75in )

        ORTSWheelCrankAngleDifference ( 0deg 90deg )

        AttachedAxle( 0 )

    )

    Comment (\*\* Rear Engine Unit \*\*)

    Steam (

        ORTSArticulationType ( Fixed )

        ORTSArticulationAnimation ( “MAIN” )

        ORTSRigidWheelBase ( 18.0ft 3.0in )

        WheelRadius ( 34in )

        ORTSNumberDriveAxles ( 4 )

        NumCylinders ( 2 )

        CylinderStroke ( 32in )

        CylinderDiameter ( 23.75in )

        ORTSWheelCrankAngleDifference ( 0deg 90deg )

        AttachedAxle( 0 )

    )

)

ORTSDriveWheelWeight ( 545000lb )

Sanding ( 25mph )

IsTenderRequired ( 1 )

)

Comment (\*\* Example 2 -- Northern Pacific Z8 Challenger \*\*)

```

Wagon ( Northern Pacific Z8
[ ... ]
CentreOfGravity ( 0m 2m 0m )
ORTSTrackGauge ( 4ft 8.5in )
ORTSUnbalancedSuperelevation ( 6in )
[ ... ]
)
Engine ( Northern Pacific Z8
Type ( Steam )
ORTSSteamLocomotiveType ( Simple )
ORTSSteamEngines ( 2
    Comment (** Front Engine Unit **)
    Steam (
        ORTSArticulationType ( Pivoted )
        ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )
        ORTSArticulationAnimation ( “BOGIE1” )
        ORTSRigidWheelbase ( 12ft 4in )
        WheelRadius ( 35in )
        ORTSNumberDriveAxles ( 3 )
        NumCylinders ( 2 )
        CylinderStroke ( 32in )
        CylinderDiameter ( 23in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        ORTSDriveWheelWeight ( 222000lb )
        AttachedAxle( 0 )
    )
    Comment (** Rear Engine Unit **)
    Steam (
        ORTSArticulationType ( Fixed )
        ORTSArticulationAnimation ( “MAIN” )
        ORTSRigidWheelbase ( 12ft 4in )
        WheelRadius ( 35in )
        ORTSNumberDriveAxles ( 3 )
        NumCylinders ( 2 )
        CylinderStroke ( 32in )
        CylinderDiameter ( 23in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        ORTSDriveWheelWeight ( 222000lb )
        AttachedAxle( 0 )
    )
)

Sanding ( 25mph )
IsTenderRequired ( 1 )
[ ... ]
)

Comment (** Example 3 -- Southern Pacific AC-12 Cab Forward **)
Wagon ( Southern Pacific AC-12

```

```

[ ... ]
CentreOfGravity ( 0m 2m 0m )
ORTSTrackGauge ( 4ft 8.5in )
ORTSUnbalancedSuperelevation ( 6in )
[ ... ]
)
Engine ( Southern Pacific AC-12
Type ( Steam )
ORTSSteamLocomotiveType ( Simple )
ORTSSteamEngines ( 2
    Comment (** Front Engine Unit **)
    Steam (
        ORTSArticulationType ( Fixed )
        ORTSArticulationAnimation ( "MAIN" )
        ORTSRigidWheelBase ( 16.0ft 11.0in )
        WheelRadius ( 31.75in )
        ORTSNumberDriveAxles ( 4 )
        NumCylinders ( 2 )
        CylinderStroke ( 32in )
        CylinderDiameter ( 24in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        AttachedAxle( 0 )
    )
    Comment (** Rear Engine Unit **)
    Steam (
        ORTSArticulationType ( Pivoted )
        ORTSArticulationAnimation ( "BOGIE2" )
        ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )
        ORTSRigidWheelBase ( 16.0ft 11.0in )
        WheelRadius ( 31.75in )
        ORTSNumberDriveAxles ( 4 )
        NumCylinders ( 2 )
        CylinderStroke ( 32in )
        CylinderDiameter ( 24in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        AttachedAxle( 0 )
    )
)

ORTSDriveWheelWeight ( 531700lb )
Sanding ( 25mph )
IsTenderRequired ( 1 )
[ ... ]
)

Comment (** Example 4 -- Norfolk & Western Y6b **)
Wagon ( Norfolk & Western Y6b
[ ... ]
CentreOfGravity ( 0m 2m 0m )

```

```

ORTSTrackGauge ( 4ft 8.5in )
ORTSUnbalancedSuperelevation ( 6in )
[ ... ]
)
Engine ( Norfolk & Western Y6b
Type ( Steam )
ORTSSteamLocomotiveType ( Compound )
ORTSSteamEngines ( 2
    Comment (** Front Engine Unit **)
    Steam (
        ORTSArticulationType ( Pivoted )
        ORTSArticulationAnimation ( "BOGIE1" )
        ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )
        ORTSRigidWheelBase ( 15.0ft 9.0in )
        WheelRadius ( 29in )
        ORTSNumberDriveAxles ( 4 )
        LPNumCylinders ( 2 )
        LPCylinderStroke ( 32in )
        LPCylinderDiameter ( 39in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        AttachedAxle( 0 )
    )
    Comment (** Rear Engine Unit **)
    Steam (
        ORTSArticulationType ( Fixed )
        ORTSArticulationAnimation ( "MAIN" )
        ORTSRigidWheelBase ( 15.0ft 9.0in )
        WheelRadius ( 29in )
        ORTSNumberDriveAxles ( 4 )
        NumCylinders ( 2 )
        CylinderStroke ( 32in )
        CylinderDiameter ( 25in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        AttachedAxle( 0 )
    )
)

ORTSDriveWheelWeight ( 548500lb )
Sanding ( 25mph )
IsTenderRequired ( 1 )
[ ... ]
)

Comment (** Example 5-- Erie Triplex **)
Wagon ( Erie Triplex
[ ... ]
CentreOfGravity ( 0m 2m 0m )
ORTSTrackGauge ( 4ft 8.5in )
ORTSUnbalancedSuperelevation ( 6in )

```

```

[ ... ]
)
Engine ( Erie Triplex
Type ( Steam )
ORTSSteamLocomotiveType ( Compound )
ORTSSteamEngines ( 3
    Comment (** Front Engine Unit **)
    Steam (
        ORTSArticulationType ( Pivoted )
        ORTSArticulationAnimation ( "BOGIE1" )
        ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )
        ORTSRigidWheelBase ( 16.0ft 6.0in )
        WheelRadius ( 31.5in )
        ORTSNumberDriveAxles ( 4 )
        LPNumCylinders ( 2 )
        LPCylinderStroke ( 32in )
        LPCylinderDiameter ( 36in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        AttachedAxle( 0 )
    )
    Comment (** Intermediate Engine Unit **)
    Steam (
        ORTSArticulationType ( Fixed )
        ORTSArticulationAnimation ( "MAIN" )
        ORTSRigidWheelBase ( 16.0ft 6.0in )
        WheelRadius ( 31.5in )
        ORTSNumberDriveAxles ( 4 )
        NumCylinders ( 2 )
        CylinderStroke ( 32in )
        CylinderDiameter ( 36in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        AttachedAxle( 0 )
    )
    Comment (** Rear Engine Unit **)
    Steam (
        ORTSArticulationType ( Pivoted )
        ORTSArticulationAnimation ( "BOGIE2" )
        ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )
        ORTSRigidWheelBase ( 16.0ft 6.0in )
        WheelRadius ( 31.5in )
        ORTSNumberDriveAxles ( 4 )
        LPNumCylinders ( 2 )
        LPCylinderStroke ( 32in )
        LPCylinderDiameter ( 36in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        AttachedAxle( 0 )
    )
)
)

```

```

ORTSDriveWheelWeight ( 761600lb )
Sanding ( 25mph )
Comment ( ** Rear driving wheel group over tender, so loco is treated as a tank engine. ** )
IsTenderRequired ( -1 )
[ ... ]
)

```

```

Comment (** Example 6 -- Chesapeake & Ohio H8 Allegheny **)

```

```

Wagon ( C&O Allegheny
[ ... ]
CentreOfGravity ( 0m 2m 0m )
ORTSTrackGauge ( 4ft 8.5in )
ORTSUnbalancedSuperelevation ( 6in )
)
Engine ( C&O Allegheny
Type ( Steam )
ORTSSteamLocomotiveType ( Simple )
ORTSSteamEngines ( 2
    Comment (** Front Engine Unit **)
    Steam (
        ORTSArticulationType ( Pivoted )
        ORTSArticulationAnimation ( "BOGIE1" )
        ORTSArticulationMaxAngle ( -2 2 -5 5 -1 1 )
        ORTSRigidWheelbase ( 11ft 10in )
        WheelRadius ( 33.5in )
        ORTSNumberDriveAxles ( 3 )
        NumCylinders ( 2 )
        CylinderStroke ( 33in )
        CylinderDiameter ( 22.5in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        AttachedAxle( 0 )
    )
    Comment (** Rear Engine Unit **)
    Steam (
        ORTSArticulationType ( Fixed )
        ORTSArticulationAnimation ( "MAIN" )
        ORTSRigidWheelbase ( 11ft 10in )
        WheelRadius ( 33.5in )
        ORTSNumberDriveAxles ( 3 )
        NumCylinders ( 2 )
        CylinderStroke ( 33in )
        CylinderDiameter ( 22.5in )
        ORTSWheelCrankAngleDifference ( 0deg 90deg )
        AttachedAxle( 0 )
    )
)

```

```

ORTSDriveWheelWeight ( 504010lb )
Sanding ( 25mph )
IsTenderRequired ( 1 )

```

[ ... ]  
)

### Further Reading

Unusual Locomotives by Douglas Self—How to Articulate “Locomotive”

<http://www.douglas-self.com/MUSEUM/LOCOLOCO/articult/articult.htm>

Uncommon Steam Locomotives Site by Gunter Krebs

<http://loco.skyrocket.de/>

Steam Locomotive Dot Com by Wes Barris—Articulated vs Mallet Locomotives

<http://steamlocomotive.com/types/mallet/>

Mallets in the Tall Timber by Jon Davis

<http://loggingmallets.railfan.net/>