How to Operate like a Pro

Introduction

The role of the professional locomotive engineer requires tremendous responsibility. As such, the training period to receive Certification lasts many months and mastering the skill of operating a locomotive takes years behind the throttle. In many ways, a locomotive engineer responsible for moving thousands of tons of equipment and goods or passengers is akin to someone controlling a wild creature. What makes trains one of the most efficient forms of transportation also makes them one of the most demanding to control. The laws of physics state, "An object in motion tends to stay in motion and an object at rest tends to stay at rest". Trains are a perfect example of this. A miscalculation on the locomotive engineer's part could possibly result in tragedy. Not only do locomotive engineers have a responsibility to their employers, but also to their co-workers and the communities their trains operate through each and every day.

In our model railroad world we operate our trains in a much more controlled environment. A derailment is often followed by frustration or laughter. Most of the time it is a result of something wrong with either our rolling stock or imperfect trackwork. In the real world, malfunctioning equipment or bad trackwork often is a contributing factor to derailments. However, the human element is always the first thing to be investigated. The use of improper procedures by a locomotive engineer can and has contributed to massive derailments resulting in millions of dollars worth of damage and even loss of life. Safety and rules compliance have always been first and foremost among the job responsibilities for railroad employees.

Follow along to learn how you can operate your new ProtoThrottle just like a professional locomotive engineer treating our model railroad trains as if they were the real thing. And as always, remember...SAFETY FIRST!

Tim Garland
Locomotive Engineer
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Chapter 1 - Locomotive Characteristics

The design of your new ProtoThrottle is based on a North American diesel-electric locomotive control stand. While not exact, the basic features are included, scaled down to fit in the palm of your hand, and offers the user a chance to control his or her model railroad locomotives just like the real thing.

All diesel-electric locomotives operate in the same manner with a diesel engine rotating a generator that produces electricity to power electric traction motors connected to each axle. This is where the similarities between models end as each type often has its own particular running characteristics. Some models were developed for a specific role or task where others are considered multi-role types and can be found in various types of service.

This chapter briefly describes the differences in how various locomotives perform compared to one another. With this knowledge, setting the decoder configuration variables (CVs) to better simulate these characteristics is a great way to provide additional realism and greater enjoyment through your ProtoThrottle.

First and Second Generation EMD units

The Electro-Motive Division (EMD) of General Motors Corporation created the best selling line of locomotives between the late 1940s and the early 1980s. Included in that line were Switchers (SW), Passenger units (E and F), General Purpose 4-axle units (GP), and Special Duty 6-axle units (SD). Horsepower ranged from 600 hp to 3600 hp. A few of these models became quite popular among the railroads resulting in thousands being built for multiple railroads. Due to parts availability and reliability, many are still active today operating in both original and rebuilt status.

The main characteristic of an EMD unit is their quick response time in amperage loading, a preferred trait among locomotive engineers. As a single or double-unit set, First Generation EMD units and Pre-Dash 2 models are quick and will began movement around two seconds after the throttle is moved from idle. Dash 2 models begin movement around three seconds after the throttle is moved from idle but are still much more responsive compared to models from other builders or newer models. For locomotive consists with four or more units, it takes an additional second for movement to allow engine brakes to release.

In order to set up your models like a prototype locomotive, it is important to allow for a delay from the time movement begins once the throttle is moved out of idle and the brakes are released. This can be accomplished by adjusting CV3 (acceleration delay) and CV4 (deceleration delay).

To accurately simulate a first generation or early second generation EMD unit CV3 needs to be adjusted for a two second delay. For all Dash-2 units, CV3 should be adjusted for to allow for a three second delay. For example, in some decoders setting CV3 to 125 will create around a three second delay in response time. And as always, for the most realistic use of the brake feature, set CV4 (deceleration delay) to its maximum setting. (Note - make sure your decoders are equipped with a brake feature and it is active to allow use of the brake function on your ProtoThrottle.)

GE units

General Electric (GE) came out with the U-series or what railfans affectionately referred to as U-boats in the mid 1960s. Though not as popular with the railroads as their EMD counterparts, GE was able to force EMD into a horsepower race, with both builders creating models capable of producing 3600 HP. By the mid 1970s, the U-series was replaced with the Dash-7 line featuring improved electronics. Once the Dash-8 series came out in the 1980s with an improved FDL16 engine, GE began to gain market share on EMD. By the 1990s, GE had become the number one builder in North America with the Dash-9 series.

The heavy duty six-axle Dash-9 series were offered in both DC and AC traction and came equipped with an all new truck design. This design was a huge improvement over the earlier six-axle models which after years of use suffer from excessive lateral movement. Excessive lateral movement occurs at speeds above 40 mph and will cause the pin connected to the truck frame to slide sideways back and forth when operating over certain track segments such as curves or turnouts. Riding inside a C40-8W when it is slamming from side to side feels as if the locomotive could jump the rails at any moment. Whenever a locomotive suffers from excessive lateral movement or truck hunting it is pretty unnerving and in fact could result in an injury for a crew member in the cab if thrown from the seat or if standing, to the floor or into a wall.

All GE units up to early production Dash-9s suffer from slow loading, taking around four or five seconds to move once the throttle is advanced from idle. Because of this, an engineer must keep the independent brake fully applied until amperage begins to increase, allowing movement to occur. This is especially true when starting a GE unit on an ascending grade. Release the brake too fast and the unit will roll backwards before it begins to load!

To realistically simulate one of these models like the prototype, CV3 should be adjusted to allow for a minimum four second delay in movement from the time the throttle is moved from idle and brakes are released.

Modern High Horsepower Units

Third Generation EMD units consisting of the 50 and 60 series came equipped with larger traction motors and new electronics. The GP50 and GP60 units with their high horsepower over 4-axles proved to be popular for lightweight TOFC intermodal trains. These units will begin moving about three seconds after the throttle is moved from idle unless in a consist of three or more where they will take four seconds. At first movement, they will start out slow and then after the next two or three seconds, a burst of power kicks in and they leap ahead. A GP60 is a thoroughbred horse made for speed which is great for intermodal trains, although it can be somewhat of a challenge when placing or “spotting” cars at industries when assigned to local work.

In terms of performance, the SD50s and SD60s load similar to an SD40-2. To accurately simulate a GP50, GP60, SD50 or SD60 adjust CV3 to allow for a three second delay for single or a two unit consist. If operated in a three or four unit consist, adjust CV3 to allow for a four second delay to best simulate the extra time it takes for the engine brakes to release.

Fourth Generation EMD SD70 units are a big improvement in reliability compared to the SD50 and SD60, but load similar to a GE Dash-9. One interesting feature of the SD70 is when they make transition around 26 mph, which is unlike any other modern six-axle unit to date. As the traction motors rotate faster, they begin to create a resistance in the electrical flow, which in turn causes the voltage in the main generator to rise. To keep from damaging the main generator the traction alternator will make transition. On board the locomotive, it is as if the locomotive just changed from low to high gear even though there is no transmission. To best simulate the SD70 series line of locomotives which also includes the SD70M-2 and the SD70ACe, set CV3 to allow for a four second delay in movement.

Modern General Electric units built after 2003 are equipped with a new 12 cylinder GEVO engine that develops the same horsepower as the 16 cylinder FDL engines found on earlier models. The “Evolution Series”, which are offered in both DC and AC traction models, were designed to meet the more stringent Tier 2 emission standards that went into effect in 2005. Regarding performance, the Union Pacific ES44AC, which UP designated “C45ACCTE”, and the BNSF ES44AC and ES44C4 units, load very similar to an SD40-2, but pack a lot more power! CSX, NS, and later UP ES44AC and ET44AC units came equipped with added weight for increased traction, although they’re not quite as quick, taking about 4 seconds to move. These units are also equipped with more powerful dynamic brakes. In fact, they are the most powerful dynamic brakes on any locomotive. For reasons such as this, railroads limit the number of dynamic brakes allowed online in a consist of modern high horsepower units.

To realistically simulate the UP C45ACCTE, and the BNSF ES44AC and ES44C4/ET44C4 GEVO units, set CV3 to allow for a three second delay in acceleration. For CSX, NS and later production UP heavy units, set CV3 to allow for a four second delay.

Chapter 2 - Train Dynamics

Steam locomotive engineers used to have a saying: “To be a good engineer, you must be able to run by the seat of your pants”. In other words, having the ability to determine how the train was operating based on whether slack action would cause one to shift on the seat in the cab of the locomotive. Good engineers can detect each time the slack in the couplers on the cars extend, what engineers refer to as “stretching”, or when it compresses, which engineers refer to as “bunching”. A good veteran engineer will keep this action to a minimum, whereas someone not so good at the controls will make you feel like your teeth are about to be knocked out! Two of the most important things a locomotive engineer must be concerned with are train speed and slack action. Keeping both under control is vital to the safe operation of the train and maintaining employment! In the prototype world either you control the train, or the train will control you.

To better understand how movements of the throttle and brake affect slack action, we first must understand train dynamics. While this is something most model railroaders will likely not concern themselves with, a better understanding will go a long way in learning how to operate your ProtoThrottle like a seasoned professional.

Power to Weight Ratio

Power to weight ratio, often called horsepower per ton ratio, has a huge effect on how a train will operate. Logically speaking, the more locomotives online under power and the more horsepower each locomotive is capable of producing, the faster one can get the train up to speed, or perhaps in some cases even to move.

Most diesel-electric Locomotives weigh in between 120-220 tons each fully loaded, so even when moving by themselves, which railroaders call “running light”, the locomotive must first overcome its own weight. As mentioned earlier, how quickly they will move is mostly centered around the characteristics of each locomotive, however there is always some lag time before the wheels will turn. Stand trackside, then watch and listen. The prime mover will rev up two to four seconds before movement.

Starting a train depends on two factors: Weight and track grade. The more weight behind the locomotive(s) and the steeper the grade the locomotives must overcome, the more horsepower is needed to begin movement. However, as Uncle Ben told a young Peter Parker, AKA Spider-Man, “with great power comes great responsibility”. In every instance when locomotives pull against cars it is essentially a tug of war. It takes the power from the locomotives to overcome the resistance from the cars to move. Add an ascending grade in the mix and the resistance is multiplied. Too much horsepower to overcome this weight could result in a train separation by breaking a coupler knuckle or possibly pulling a drawbar completely out of the end of a car near the front or “head-end” of the train. For this reason, railroads limit the number of locomotives an engineer can have “online” or under power at the front of the train for any given track segment. Even so, a locomotive engineer still must manage throttle settings at lower speeds when starting movements of tonnage trains.

Draft versus Buff Forces

The makeup of the train and the types of cars it is made up of will determine the maximum amount of slack throughout the entire train length. For example, on a 100 car freight train made up of various types of rolling stock there may be up to 50 feet of slack in the couplers. Modern equipment produced after the 1970s can be equipped with cushion draft gear that produces a greater amount of slack than rigid frame cars. A cushion underframe equipped freight car allows the coupler to slide in and out of the draft gear using a spring to protect the load from damage. Boxcars, covered coil cars, flat cars, gondolas, refrigerated boxcars and multi-level auto racks can or all be equipped with cushion draft gear. Rigid underframes can be found on boxcars, covered hoppers, flat cars, gondolas, hopper cars and double-stack cars. It is always good practice to have loaded rigid underframe cars ahead of cushion underframe cars in a train if possible.

“Draft force” deals with how hard the train is stretched at any given time. When these forces exceed the amount of pressure that can be exerted on the couplers the result is a broken knuckle. In other words, stretch the train too hard and too fast, and you’ll likely experience a separation. Draft forces can be considerably higher when the makeup of the train consists of large blocks of empties on the head-end followed by large blocks of loaded cars on the “rear” or end of the train that can act like a giant anchor trying to win the game of tug of war with your locomotives. In order for a locomotive engineer to keep draft forces at a minimum, care should be taken with the throttle when stretching a train from a stop or traveling through undulating territory.

“Buff force” is just the opposite of draft force and deals with the amount of force of impact when the train is bunched together. Too much buff force can actually result in an uncoupling lever lifting up and uncoupling the train or worse resulting in a derailment with a car being forced off the track. This is possible when an empty car between blocks of loaded cars is pushed off the track by heavy slack action. Most of the time an event such as this will occur when the train is traveling through a siding turnout or crossover located at the bottom or on a descending grade. Modern high horsepower locomotives with extended range high capacity dynamic brakes can develop enough buff force to derail an empty in this situation. For this reason, rules require engineers to reduce the amount of dynamic brake amperage until ⅔ of the train has traversed through a turnout or crossover.

Train versus Terrain

Unless the territory that you model is a water level route near the ocean, the line will likely consist of grades. Railroad civil engineers do their absolute best when laying out where a track will go to keep the gradient of the line to a minimum. Heavy grades are not only found in mountainous territory, many are in some unlikely places, including large metropolitan areas. Some grades may go on for miles, while others may be short and travel through what railroaders call “rip-rap” territory where the track is constantly either ascending or descending. In rip-rap a mile and a half long train can extend over multiple grades at the same time.

Railroad timetables are a great source to find out what tonnage a locomotive is rated for over a particular district. For railroads to figure out the maximum amount of tonnage a particular unit is capable of moving over the train’s route they must first determine the ruling grade. The ruling grade is typically the longest and the steepest grade the train will have to conquer. Too much tonnage and not enough horsepower to pull the train over the ruling grade more than likely will result in a stall and will require the train to either be broken into two sections and doubled over the grade or receive assistance from another set of locomotives from either the front or a shove from the rear of the train. In some cases, helper locomotives are permanently assigned to certain locations to assist tonnage trains over the ruling grade.

Even though trains are normally made up at their originating terminal with adequate power to conquer the ruling grade, it is not unusual to have a locomotive failure enroute. In this instance the remaining locomotive(s) not only must be able to pull the train, but the additional tonnage of the dead locomotive in the consist. Locomotive failures often occur when engines are operating under max load attempting to conquer an ascending grade resulting in a stall. At that point a decision must be made with the dispatcher on how to address the situation. The next chapter will discuss how to best simulate operating a train over grades with your ProtoThrottle.

Chapter 3 - Throttle Operation

Now that the "why" and "what" have been discussed in Chapters 1 and 2, it is time to begin the "how": How to operate the ProtoThrottle like a pro. Be sure to keep in mind what has been discussed to this point to understand why locomotive engineers utilize the controls the way they do. This chapter will deal with three different applications consisting of multiple scenarios: yard switching, local duty, and road service. Each will require a different approach to using the ProtoThrottle. In every case, be sure to constantly keep in mind how the simulated tonnage in your model railroad rolling stock would affect how your locomotives would react in the real world. As mentioned in the earlier chapters, the characteristics of the locomotives and power to weight ratio will play a huge factor in utilizing the ProtoThrottle in the most realistic manner possible.

Yard Switching

Switching “cuts” or “blocks” of railcars in the yard is something many will enjoy most with the ProtoThrottle. As a matter of fact, it is perfectly designed for this type of work. Often in a rail yard, the rail cars are “bled off”, which means their air reservoirs have been emptied. This allows the cars to roll freely, enabling a yard crew to "kick" or "drop" the cars into a track. To keep cars from rolling out of the track, a sufficient number of handbrakes are applied at one end of the line of cars to hold them securely. Normally this is done on the last two or three cars in the track, although certain instances where the yard contains a grade may require more. If necessary, or if rules require, cars in the yard are sometimes switched with air. The ProtoThrottle makes it easy to simulate both.

The type and number of locomotives in a consist will determine how to use the throttle. Operating with a single unit is definitely different than with two or more. For instance, it takes a lot more power for a single SW1500 switcher to start a cut of cars than two GP38-2s. Another thing that has to be considered is the total number of units in a consist. A one- or two-unit consist will release the engine brakes fairly quickly, but consists of three, four, or five units will definitely require more time for the brakes to pump off once released, thus allowing the locomotives to move.

The first simulation involves moving a one- or two-unit consist “light” without any cars. In this scenario, we will assume the track gradient is fairly level. Use the method below as a guide:

1. Turn the headlight on dim for both ends of the consist or locomotive.
2. Move the reverser handle to the desired direction of travel.
3. Activate the bell and open the throttle up to notch two or three.
4. Release the brake.

5. As the unit or units begin to move, prepare to notch down to one or idle to keep the speed under the speed limit. If inside engine terminal limits this should be 5 mph. On yard tracks, keep the speed no more than 10 mph. Once outside of the engine terminal limits or after moving a few car lengths on any other track the bell can be deactivated. (Note: The bell should be used for the initial movement, it is not necessary or realistic to use it during continuous switching operations unless as a warning device for people near the tracks.)
6. If traveling light through the yard for extended distances, it may be necessary from time to time to increase the throttle to notch two to keep the speed constant or if necessary, even apply a small amount of brake from time to time to keep the speed under control.
7. Move the throttle to idle and coast a few car lengths prior to reaching the desired stopping location. A car length on the railroad is considered the same as a standard 50' boxcar. (Conductors use their best judgement to estimate this distance when instructing engineers via radio communication regarding how many car lengths are needed to travel when shoving or in situations where the engineer's vision is impaired such as running a locomotive in reverse around sharp curves. Rules dictate conductors to issue adequate car length information to the engineer, otherwise if the train has traveled half the distance from the last set of instructions the movement must be stopped. For example, if the conductor states: "clear for 10 car lengths" and the engineer has moved half the distance without receiving further instructions, the train must be stopped. Once the car count reaches 5 car lengths, then instructions need to be given for every car, such as: 5 cars, 4 cars, 3 cars, 2 cars, 1 car, ½ car, 15 feet, 10 feet, 5 feet, that'll do. Within the 5 car count the movement must be stopped if no instructions are received after moving each car length. This is for the conductor's protection in the event he or she has lost radio communication with the engineer, or worse, has fallen from the equipment.)
8. Utilize the brake to slowly bring the unit or units to a stop at the designated location or a coupling. (Couplings should be made at a very slow speed, preferably 2-3 mph. If you push the standing car or cars back 30 scale feet, you hit them too hard and your model railroad engineer has been thrown from the seat!)
9. After stopping, keep the brake applied and center the reverser.
   Note: If you've made a coupling (or "joint") at this point, or if you've stopped one car length short of a joint to allow the conductor to align couplers, the conductor may call for "three-step protection" or on some railroads, "red zone protection" to ensure that the engineer won't move the train while the conductor works between cars. This involves the engineer fully applying the engine brake and a sufficient amount of train brake, centering the reverser and dropping the generator field switch on the control stand.

   The exact radio script for this varies by railroad and region, but an example is below:

   Conductor: "3 step protection, conductor 153" (train number)
   Engineer: "8101 (engine number), 3 step protection, conductor 153"

At this point, the conductor is free to step in between the cars. When the work there is complete and the conductor is again clear of the cars, an exchange much like the following will take place:

Conductor: “release 3 step protection, conductor 153”
Engineer: “3 step protection released, conductor 153”

Upon 3 step protection release, the engineer can release the train line air brakes and flip up or close the generator field switch while keeping the engine brake applied and reverser centered until receiving the next set of instructions from the conductor.

In the second scenario, we will pull a block or a "cut" of 12 cars out of yard track number 5. (Yard tracks are numbered with the lower number nearest to the mainline.) In this case track 5 is filled with a mixture of loaded and empty cars. Keep in mind the power to weight ratio as discussed earlier. A yard track of 12 or more cars, especially one containing loads will require a lot more effort for a single SW unit to get started than for two GP38-2s or SD40-2s.

In this case our yard job has two GP38-2 units. If you are using a single SW unit, you may need to increase to notch five or six initially to get the cars moving after stretching the slack.

1. Move the reverser the correct direction of travel.
2. Begin pulling the slack out of the cars or "stretching the track" by moving the throttle to notch one or two.
3. Release the engine brake.
4. As the slack is stretched, add more power by increasing to notch three, four or five to get up to but not exceeding 10 mph.
5. With the track moving and the speed increasing, prepare to notch back down to keep the speed under control.
6. Once the conductor repeats “5 cars” to clear start slowly working the throttle back to idle.
7. Unless speed is below 5 mph at “3 cars” you should be able to be in idle and coast before slowly activating the brake to bring the cars to a stop. (This will take some practice and it is okay to roll past the switch a half a car up to a car length as this is entirely prototypical.)
8. Once stopped, keep the brake applied and center the reverser.

In the third scenario we will shove the cut of cars pulled from track 5 in the previous scenario to a coupling on yard track 4. The conductor needs four loaded cement hoppers from the rear of the track of the previous scenario for an outbound train. The distance to travel is approximately three car lengths.

1. Move the reverser towards the direction of travel.

2. Increase the throttle to notch three.
3. Release the brake.
4. After movement begins, be prepared to notch back to idle.
5. Before the cars pick up too much speed, notch back down to idle and let the momentum of the weight of the cars pull the locomotives into the track.
6. Prior to reaching the coupling begin applying the brake slowly to keep draft forces at a minimum. For best results, cars should be fully stretched before impact.
7. Use engine brake to slow cars, bringing speed below 4 mph prior to coupling. (Again, if the cars in the track move more than ½ car length then you have coupled too hard and risk lading damage!)
8. After stopping, keep brake fully applied and center the reverser.

After successfully coupling to the cars currently in yard track 4 we will ‘shove’ or add the four loaded cement cars, plus clear an additional two car lengths in the track for an upcoming move. Track 4 currently contains six loaded hoppers of sand and the track is long enough to hold 12-50’ cars. As we coupled with the slack stretched, we now have a case where we now have a total of 16 cars both bunched and stretched. The conductor should relay to the engineer to “shove 6 car lengths, clear for 6 on the rear”. This information lets the engineer know not to get too carried away when making this next move. Keep in mind there’s no air brakes on the cars and the only method of stopping are the engine brakes.

1. Move the reverser towards the direction of travel.
2. Increase the throttle to notch two.
3. Release the brake.
4. Slowly bunch the slack in. If speed slows after cars are bunched, increase throttle to notch three, four, five or six depending on power per weight ratio.
5. Once underway, start to reduce throttle settings allowing the cars to slow the movement.
6. Depending on speed, prepare to decrease the throttle to idle and apply the engine brake slowly to stop the movement. (Keep in mind we have a total of 10 heavily loaded cars on the rear that will stretch rather hard if you apply the engine brake too fast.)
7. After stopping, the conductor states “slack on the pin” or “a little pin”. Increase to notch two and release the brake to bunch the cars to allow conductor to uncouple the standing equipment.
8. Once conductor states “that’ll do, pull ahead.” Apply the brake and then move the reverser to the opposite direction of travel, increase the throttle to notch two and release the brake.
9. As slack is stretched, increase the throttle to three or four and pull ahead to clear the switch.
10. At around three or four car lengths to clear, drop back to idle and coast preparing to brake.
11. Prior to clearing switch slowly apply the brake to bring the movement to a stop.
12. After stopping make sure brake is fully applied and center the reverser.

In the next scenario the conductor wants to shove the remaining 8 cars back into track 5. The track is long enough to hold 12-50' cars. With the switches lined, the conductor issues instructions for the engineer to "shove 12 car lengths, clear for 16." (This distance includes the track length plus the length of the turnouts.)

1. Move the reverser to the desired direction of travel, increase to notch two or three and release the brake.
2. Once movement begins and slack is bunched increase to notch four.
3. As speed approaches 10 mph, reduce throttle back down to three, two and then one.
4. When conductor states "5 car lengths", reduce all the way to idle and coast.
5. If speed drops too rapidly, notch back up to one to keep moving, then notch back to idle.
6. At "one car length", start applying brake to bring the cars to a stop.
7. After stopping make sure brake is fully applied and center reverser.
8. When conductor requests for slack on the pin, move reverser to direction of travel, increase to notch two and release brake.
9. After movement and the conductor says "that'll do", decrease to idle and apply brake.
10. When the conductor issues instructions to go the other way move the reverser to correct direction, increase throttle to notch three and release brake.
11. After speed starts to increase reduce throttle back down to one or two and then idle prior to reaching stopping point.
12. One car length from stopping point, apply the brake and center the reverser.

In the last Yard Switching scenario we will perform something rarely done on a model railroad and that is to "kick" or "drop" a car. For best results it is helpful when designing your layout to create a shallow bowl effect for your yard. In this case both ends of the yard will be slightly higher than the middle. If designed correctly, this can be very fun and prototypical. A good rule of thumb is to keep the main middle part of the yard level and slightly raise each of end of the yard tracks including the ladder no more than ½ inch. This bowl shaped yard is entirely prototypical. Be advised this scenario is best completed with two operators; an engineer and a conductor. The conductor will need an uncoupling pick to complete this procedure and it works best with free rolling freight cars equipped with metal wheelsets.

After coupling to track 2 in the yard the conductor needs to pull it down a few car lengths, and then uncouple or "make a cut" on two refrigerator boxcars needed for the outbound local train that is being built in track 4 with the sand and the cement. Once the cut has been made, the remaining cars including the two refrigerator boxcars are pulled "high" or past the switch. Since we made room earlier by clearing the additional two car lengths in track 4 when we shoved the cement covered hoppers, it is the perfect opportunity to "drop" or "kick" these two into the track, thereby saving time. Follow along to learn how to accomplish this move and simulate what happens on the prototype on a daily basis. After the conductor states to "kick 'em" or "give me a little start" proceed with the following:

1. Move reverser to desired direction of travel, increase the throttle all the way to notch four and release the brake.
2. After slack is bunched the conductor can use the uncoupling pick to uncouple the two refrigerator boxcars while the cut is being shoved. When the speed is good enough for the cars to roll freely to a coupling, the conductor will state “that’ll do! or “good!”. As soon as this happens, immediately decrease the throttle to idle and fully apply the brake without hesitation.
3. After the movement stops, keep brake fully applied and center the reverser until further commands from the conductor.
4. When the movement ends with the remaining cars attached to the engine, conductor will state “pull ahead” to clear the track 2 switch, then if we made the cut earlier with enough clearance, can drop or kick the remaining cars back into track 2.

Local Duty

For local duty we will use a single SD40-2 for power. Use the first scenario on how to move a light engine from the engine terminal to the yard. Our train was previously built by the yard job in yard track 4 and consists of 12 cars; two modern high cube refrigerator boxcars, four small two bay cement service covered hoppers and six small two bay aggregate hoppers of sand. We will be working two industries; a cold storage warehouse and a concrete company.

After coupling to the track with our cars and performing a brake test the conductor hangs a flag on the last car and we are now officially a train. Pull the cars out of track 4 in the same fashion as mentioned in the earlier scenario keeping the speed below 10 mph while in yard limits. Manipulate the throttle to control the speed by increasing or decreasing notches as appropriate.

The cold storage warehouse and the concrete company are both located on an industrial park spur off of the main-line not far from the yard. After getting permission from the dispatcher to enter the main, pull the train off of the yard lead past the main-line switch and stop the train allowing the conductor to return the mainline switch and derail to normal position and then walk to the front or "head-end" of the train. Use the same method as before going to idle and coasting a few car lengths prior to applying the brake. Be sure to remember to keep the brake fully applied and the reverser centered while stopped.

With the conductor now on the head-end of the train it is time to "knock the brakes off" which simply means to release the brakes and start towards the industrial park spur. Since our SD40-2 is equipped with an extended range dynamic brake, prior to reaching the spur we will utilize it to slow the train to a stop. Follow along to complete this move.

1. Turn headlight on bright for the direction of travel and if equipped, activate the ditch lights.
2. Move the reverser to the desired direction of travel.

3. Increase throttle to notch two.
4. Slowly release the brake and allow train to stretch.
5. Increase throttle slowly from notch two to notch five with about two seconds of delay between notch positions.
6. Run restricted speed at or below 15 mph until about 15 to 20 car lengths away from switch entrance to Industrial Park.
7. Reduce throttle slowly to idle and coast a few seconds.
8. Activate the dynamic brake switch. (If locomotive is equipped with ESU Full Throttle, increase throttle to notch 3 and hit drive hold to lock in the speed step. When nearing the switch for the industrial spur lead decrease throttle to idle and take out of Drive Hold to allow movement to come to a stop.)
9. Allow the train to slow and at two car lengths from the switch deactivate the dynamic brake use the engine brake to bring the train to a stop making sure to get the train stopped short of the switch to the industrial spur.
10. Keep the brake fully applied and center the reverser.

In the second scenario we will work the Concrete Company but first we must travel down the Industry Spur lead which contains a steep 4 percent descending grade before leveling out prior to reaching the industry. After stopping to line the switch for the industrial spur lead, the conductor will remain at the switch in order to line it back for the main after the train is in the clear. Once clear from the mainline, the train will need to be stopped to allow the conductor to board the last car. Since the main is at the top of the grade for the spur this will be a challenge to keep the train under control to prevent a runaway. Follow along to see how to accomplish this move. Remember the Railroader's Motto...Safety First!

1. Move the Reverser to the desired direction of travel, increase throttle to notch two and slowly release the brake.
2. As slack begins to stretch, increase throttle to notch 3.
3. Ring bell and sound horn for a crossing that crosses Industrial Spur Lead. Per FRA requirements horn sequence should be a minimum of 15 seconds, including two long blasts, one short blast and one more long blast with the last sound ending once the train is in the middle of the crossing.
4. Slowly reduce throttle to notch one and then idle.
5. Coast a few car lengths before applying Engine Brake to stop movement once clear of the main. Keep brake applied and center reverser.
6. After conductor lines switch back for main and radios to "Pull ahead", move reverser for direction of travel and increase throttle to notch two.
7. Release brake and increase throttle to notch three to get the train moving.
8. Reduce throttle to idle and activate dynamic brake.
9. If Locomotive is equipped with ESU Full Throttle increase throttle to notch 3 and activate Drive Hold. Near bottom of grade reduce throttle to idle and deactivate Drive Hold.
10. At bottom of grade deactivate dynamic brake.

11. Increase throttle to notch three or four keeping speed under 10 mph.
12. Prior to reaching the industry reduce throttle to idle.
13. At two cars remaining to clear industry switch slowly apply engine brake.
14. When stopped, fully apply brake and center reverser.

The Argos Concrete Company has two tracks; one for sand unloading and one for cement unloading. The sand track will hold six cars and currently has five empty cars ready to be pulled. The cement track will also accommodate six cars, currently has four cars, but only two have been emptied. The customer requests all inbound cars to be spotted behind any remaining loads at the rear of the track. Follow along to see how to complete this next scenario.

The conductor has lined the switch for the industry and removed the derail along with lining the next switch for the sand track. Prior to coupling to the empty cars, the conductor must make an inspection to make sure that none of the cars are connected to a car puller, have been damaged or derailed by the customer, or have hopper doors still open. Once this is complete radio instructions are sent to the engineer that all "switches have been lined and derail is off." The empty cars appear to be approximately five car lengths away so the conductor's next instruction is to "shove 5 car lengths to a coupling". After movement begins, the conductor will count down each car length traveled to the engineer. Once within one car length from the coupling, he or she can state "half a car, 15 feet, 10 feet, 5 feet and then "That'll do!" or "Good!". (Note that engineer's do not have to repeat instructions concerning car lengths for any amount under five car lengths due to the extra effort needed on the controls at this time.)

1. Move reverser to desired direction of travel, increase throttle to notch 3 and release the brake.
2. As movement begins prepare to notch back down to idle.
3. Prior to reaching coupling coast a car length or two and then apply brake.
4. If movement stops before coupling is made, increase throttle to notch 2 and release brake.
5. Once movement starts again decrease throttle to idle and apply brake coupling to the cars.
6. Keep brake fully applied and center reverser. Conductor will request protection for working on and between the equipment. Allow time for the conductor to work air hoses and release hand brakes from cars. (This can be around 5 seconds per car).
7. With cars now ready to be pulled we need to set the empties out on the main lead. Conductor radios to engineer to release his or her protection and and to pull ahead. Engineer repeats "protection released, pulling ahead". Move reverser to desired direction of travel and increase throttle to notch 2.
8. Release brake and then increase throttle to notch 3 or 4 after slack is stretched.
9. When conductor radios 5 car lengths decrease throttle to idle and coast the next 3 car lengths.
10. At 2 car lengths begin applying brake to time movement to stop clear of the switch.

11. Fully apply brake, center reverser and wait for instructions to set empty cars clear of industry on the main lead.

After all five empty sand hoppers are set out it is now time to spot the six loaded sand hoppers. The sand track has enough space to hold exactly six cars with an additional 15 feet to spare before reaching the bumping post at the end of the track. The loads need to be shoved to the rear of the track with the first bay of the lead hopper spotted over the unloading pit. The customer uses a car puller to move the cars as they are emptied towards the derail. In this scenario the conductor will ride the last car stopping one car length from the end of the track for safety. Then will walk up to the pit area to spot the lead car for unloading. Follow along to see how to spot cars over a pit using your ProtoThrottle.

1. Move reverser to the desired direction of travel, increase throttle to notch 3 and release brake.
2. If necessary increase throttle to notch 4 to build up some momentum. There is approximately 12-50' car lengths from the switch to the end of this track.
3. Keep speed under control not exceeding 7 or 8 mph in this track due to its condition. Reduce throttle to notch 2 or 3 if necessary.
4. At five car lengths from the end of the track reduce throttle to idle and coast.
5. At three car lengths begin braking to stop movement within one car length from the end of the track. It does not have to be perfect just within the range.
6. Now that the movement has stopped keep brake applied and center the reverser while the conductor walks up to get in position to spot the cars.
7. Conductor issues instructions: "I need 30 feet for a spot, clear for one car length on the rear." Move reverser in desired direction of travel, increase throttle to notch 2 and slowly release the brake.
8. As movement begins apply ½ brake and continue in notch 2.
9. within 5 or 10 feet from the spot decrease to notch 1 if necessary to slow movement within 2 mph.
10. As soon as conductor responds "That's good" or "That'll do", simultaneously fully apply brake and decrease to idle.
11. Center reverser and allow ten second delay for conductor to apply handbrakes to two of the cars.
12. After conductor releases his or her protection, uncouples the equipment and issues instructions to pull the remaining cars from the track, move the reverser to the desired direction, increase the throttle to notch 3 and release the brake. As unit begins to move prepare to reduce throttle slowly to idle and coast before applying brake stopping movement once clear of the switch. Keep brake applied and center the reverser.

Now that we have spotted the sand track, our next scenario will be pulling and spotting the cement track. Since the customer only unloaded two of the four cars at the industry we first need to couple the inbound loads to the empty sand hoppers on the industrial park lead and shove them past the industry switch. We will hold onto the two refrigerator boxcars to couple to the cement hoppers in the industry. In this case however we have a new situation. The industry has used their front-end loader with a special coupler attachment to move the empty cars off of the unloading pit towards the derail and left them in a curve creating a challenge to couple. The conductor will need to make a safety stop one car length from the coupling and check for coupler alignment. Follow along to see how this procedure is made and what to do in case of a mis-alignment.

1. The conductor has issued the following instructions, “Switch lined, shove four car lengths to a safety stop.” After repeating the instructions begin by moving reverser to direction of travel, increase throttle to notch 2 and release the brake.
2. As movement begins prepare to notch down to one and then idle.
3. Coast one car length before applying brake to stop.
4. After stopping keep brake applied and center reverser. Provide protection for conductor to work between equipment and inspect empty cars prior to coupling.
5. Once conductor releases his or her protection and instructs to shove one car to a coupling, move the reverser towards the desired direction of travel, increase the throttle to notch two and slowly release the brake.
6. When movement begins continue to keep speed slow (2-3 mph) and prepare to drop to idle and apply brake.
7. After stopping, conductor notes that the couplers mis-matched and issues instructions to slack off a car length to go between the equipment adjust the couplers.
8. Back off the cars and reapply protection for the conductor to adjust the couplers. (Note - prototype rolling stock do not have coupler centering springs which allow the couplers on longer equipment to sway off to the side when operating around curves. Modelers can simulate this same effect by not including centering springs on cars exceeding 70’ in length.)
9. Repeat steps 7 and 8 to couple to cars.
10. Once coupled to the two empty cars, keep brake applied and center reverser. Apply protection for conductor to release handbrakes and work air hoses.
11. Conductor releases his or her protection and issues instructions to shove two more car lengths to couple to the two loaded cars at the unloading shed. Use steps 7 and 8 as a guide to make this coupling.
12. After conductor releases request for protection instructions are given to pull ahead and clear the main lead switch. Move reverser to the desired direction of travel, increase throttle to notch 3 and release the brake.
13. Once movement begins prepare to notch down to 2 to control speed.
14. At five cars to clear switch prepare to notch down to 1 and then idle at two or three cars coasting before applying the brake.

15. At ½ car length to clear fully apply brake. If movement attempts to stop prior to clearing switch, release brake and if necessary increase to notch one. Once clear keep brake fully applied and center the reverser.

After coupling to the loaded cement covered hoppers on the main lead, pulling down to make the cut from the empty sand hoppers and then pulling loads clear of the industry siding switch it is now time to spot the cement track side of the industry. This will require a similar technique that was used to spot the sand except it will require more precision since the area where the cars are unloaded is a lot smaller. In addition, this scenario has a situation where the conductor can not ride on the side of the equipment through the unloading shed due to a close clearance. A safety stop will need to be made prior to reaching the unloading shed. Follow along to see how to complete this next move.

1. Move reverser to direction of travel, increase throttle to notch three and release brake.
2. Reduce throttle if necessary to keep speed around 5 mph due to track condition and activity at industry.
3. Prior to reaching unloading shed, reduce throttle to idle, coast at least a car length and slowly apply brake. Once slack is stretched, full brake can be applied to stop movement to allow conductor to dismount.
4. With conductor walking ahead of the move, increase throttle to notch two and release brake.
5. Conductor will stop movement one car length short of end of track and then walk back to unloading pit to spot head car.
6. When spotting car, use both brake and throttle keeping speed no more than 2 mph. To perform this move increase throttle to notch 2 and apply ½ or more of brake. Drop to notch 1 if necessary.
7. As soon as conductor states "good!" then fully apply brake and drop throttle to idle without hesitation. If cars are shoved past mark, change reverser direction, increase to notch 1 and slowly release part of the brake until movement begins. Once on spot, reduce throttle to idle, fully apply brake and center reverser. Provide protection for conductor to secure equipment.
8. After protection is no longer needed, pull two loaded refrigerator boxcars and two empty covered hoppers back to main industry lead, reapply derail and line industry switch for main lead.
9. Couple to empty sand hoppers using earlier methods.

To work the Cold Storage facility we first must run around the equipment using a double-ended siding adjacent to the Concrete Company. Use the same method for operating a light unit to complete this move. After coupling to the other end of the cars and making sure the air brakes are functioning properly, we are ready to proceed with our loaded refrigerated boxcars now located at the rear of our train. To reach Nordic Cold Storage we first must pull past another switch on the industrial park lead located on the 4 percent grade. This will require a different approach to deal with the steep grade. Follow along to see how to use the ProtoThrottle to perform this procedure.

1. Move reverser to the desired direction, increase throttle to notch two to stretch slack and then release the brake.
2. After slack is stretched increase throttle to notch 3 to gain momentum while keeping speed under 10 mph. (Note - if locomotive is equipped with LokSound Full Throttle feature activate Drive Hold to maintain 10 mph.)
3. Prior to reaching switch, decrease throttle to notch 1 (deactivate Drive Hold if equipped) and allow speed to decrease enabling the conductor to dismount from unit below 4 mph.
4. When conductor dismounts at switch, increase throttle notches every two to three seconds up to notch 5 or 6 keeping speed below 10 mph.
5. As conductor counts down car lengths to clear switch use throttle modulation to slow train on the ascending grade. Decreasing the throttle slowly will essentially create a stall situation with the grade while keeping the slack stretched. (Decreasing it fast will cause the slack to run in first and then back out on the grade once the movement is stopped.) When stopping a train on an ascending grade the throttle can be used right up until the movement is stopped.
6. Upon notification that the switch has been cleared by the conductor, fully apply the brake, move the throttle to idle and center the reverser.
7. Once conductor lines switch for movement and states how many car lengths are seen to be clear, move reverser to desired direction, increase throttle to notch two and release brake.
8. Since this shove move is starting out with the train descending on a grade we will need to use the brake to control the movement. In addition, prior to reaching the switch for Nordic a non-signaled street crossing will require the train to stop and flag before movement through the crossing. Slow the train for a stop by decreasing the throttle to idle and coasting before slowly applying the brake. The slack should roll out smoothly to keep from slinging the conductor off the end of the last car. Once stopped, keep brake applied and center reverser.
9. With the traffic stopped by the conductor begin shoving again and stop short of the Nordic switch using earlier methods as a guide.

The last scenario will involve spotting the two 64’ high cube refrigerated boxcars. The Nordic Cold Storage Warehouse has been around for three decades and is equipped with four doors designed for the older 57’ cars to be spotted without having to be uncoupled. Only two of the large 64’ cars can be placed at a time by skipping over a door between. Follow along to see how to use the ProtoThrottle to complete this task.

1. With the switch lined and derail in the off position the conductor will first check to make sure the track inside the industry along with the area around the track is clear of any people or obstructions. Once clear the conductor radios: “switch lined, derail off, ahead

of the move, clear for 7 cars". Engineer will repeat the instructions and then move the reverser, increase throttle to notch 3 and release the brake.

2. Once movement begins, reduce throttle to notch 2 to control speed around 5 or 6 mph.
3. With the conductor positioned on the ground to spot the rear refrigerator boxcar at the second door from the rear of the track, instructions are given to count the cars down to a spot. When within 2 car lengths to a spot, reduce throttle to notch 1 to slow movement to 2-3 mph.
4. With speed reduced, add ½ brake and increase throttle to notch 2 if necessary.
5. As soon as conductor states "that'll do", apply full brake, reduce throttle to idle and center reverser.
6. With the first car spotted and protection issued for the conductor to secure the car it is now time to spot the second car. The conductor releases 3 step protection and issues instructions to "slack off 30' to a spot". Move reverser, increase throttle to notch 1 and release brake.
7. As cars begin to move, add ½ brake and increase throttle to notch 2. If speed increases too fast reduce throttle to notch 1.
8. When conductor states "that'll do" apply full brake and reduce to idle immediately. Center reverser when stopped to apply 3 step protection for the conductor to secure the car.

Road Service

In addition to Yard and Local service, the ProtoThrottle can also be used for Road Trains. Road trains on the mainline often require a different approach to train handling than yard and local trains. Road trains are generally longer and heavier, thus managing draft and buff forces are much more important. Engineers must familiarize themselves with the territory that they operate their trains through for safe and efficient operation. In addition to grades, engineers must have knowledge of all speed restrictions including temporary (slow orders) and permanent (excepted track, curves and city ordinances). Note - To figure out the scale speed of each throttle notch on your models an electronic device such as one made by Accutrak is recommended.

We will complete two scenarios dealing with mainline trains; hotshot intermodal and a mixed freight with distributed power ⅔ back from the front of the train. Both trains will be handled completely different in two different situations. Follow along to see how to use your ProtoThrottle in road service. If needed, refer back to chapter 2 on train dynamics for a refresher on draft and buff forces along with power to weight ratios.

In the first scenario we will be handling a hotshot intermodal train equipped with three brand new BNSF ET44C4 locomotives. The train contains both loaded double-stack cars filled with 53' containers and a couple of articulated spine cars loaded with trailers on the rear. It is operating on CTC signaled territory. During this scenario we will need to slow the train for a temporary speed restriction at a reported malfunctioning grade crossing. The dispatcher has given us a slow order for the speed to be reduced to 15 mph prior to reaching the crossing applying to head-end only, meaning once the engines clear the crossing, track speed can be resumed. Track speed for this section of track is 40 mph due to a permanent town ordinance and a two permanent curve restrictions located at both ends of the town. The town is located on a plateau and the grade crossing we need to slow for is located in the center of town. We will begin this scenario with the train already moving at 40 mph climbing a two mile one percent grade in notch 8. All three units are online and the power to weight ratio is 3 to 1 or 3 HP/Ton.

1. Continue in notch 8 for ½ mile climbing grade. At 1 and ½ mile from speed restriction (on a model railroad we can condense this down to about 30 or 40 car lengths) slowly start decreasing throttle notches to allow grade to slow train's speed while continuing to keep slack stretched.
2. If speed is not dropping fast enough for the slow order, decrease throttle to idle, coast a few seconds and then activate dynamic. Since we still have the train on an ascending grade activating the dynamic will create buff force. Care must be given to keep this to a minimum.
3. Once speed is near 15 mph, it is time to slowly start stretching the train back out. By doing this slowly the draft force will actually act like a brake and slow the train further. We must keep this draft force to a minimum to avoid breaking a knuckle at this point. Coming back out on the throttle by notching up too fast will in essence "crack the whip" and the force of the train pulling back against the power of the locomotives pulling in the opposite direction will exert a lot of strain on any weak couplers near the front of the train. After releasing the dynamic brake, wait a few seconds and then increase throttle to notch one or two.
4. Now is the time to "run by the seat of your pants". We need to feel the slack in the train run out before we advance the throttle further. Imagine each car in the train slowly stretching back out. In the cab it is often a succession of tugs. In cases where empty cars are located on the front of the train and loaded cars are at the rear you may feel one big tug once the loaded cars stretch the empties. Once this tug of war is finished we know we have the train stretched out again. If we are still shy of the crossing and our speed is beginning to drop below 15 mph then we can advance the throttle to 3 or 4 at this time.
5. With the bell activated and two long blasts on the horn followed by one short blast and another long blast we have now cleared the crossing with our lead locomotive. If we have already performed step four and stretched our train out now we can "get after them" and get the train back up to speed. If you are in notch 2 or 3, slowly start increasing notches every 3 or 4 seconds until you are back in notch 8.
6. With speed increasing and a 3HP/ton power to weight ratio it will not take long to get the train back up to speed. At the edge of town we round another 40 mph curve and must get the entire train through the curve before we can increase the speed further to the 50 mph max speed beyond it. Also, just beyond the curve the track begins to descend down another 1 percent grade for the next mile before starting upgrade again. As speed reaches 30 mph and the front or "head-end" of the train starts downgrade with the train still in the 40 mph curve slowly begin notching down to idle.

7. As more of the train starts down the grade, speed will continue to increase. After remaining in idle for a few seconds, activate the dynamic brake. (Note - if your locomotives are equipped with LokSound Full Throttle, increase throttle to notch 6 and hit the drive hold function to lock in the speed step.)
8. At the bottom of the grade, make sure throttle is in idle and deactivate the dynamic brake. After this immediately go to notch 4 and then increase notches every 2 or 3 seconds until back in notch 8.

In our last scenario we will operate a freight train with Distributed Power or DP units. (Locomotives equipped for Distributed Power have radio control equipment which can receive radio signals from the lead locomotive. This allows the engineer on the lead locomotive to control the units as if they were actually MU'd in a consist on the head-end of the train, or can control manually from the computer screen on the lead locomotive. DP units are typically located either somewhere in the middle or on the rear of the train. They have been proven to improve overall train dynamics and conserve fuel.)

This will be a heavy train with two SD70ACe units up front and a single ES44AC unit two-thirds back in the train. We will operate this train through the same town as the earlier Intermodal train from the previous scenario, however the crossing gates have been repaired and there is no longer a temporary slow order. This train is twice as long as the intermodal and three times as heavy with a much lower power to weight ratio. Follow along to see what it takes to be an engineer on a big train like this using your ProtoThrottle.

1. We begin this scenario in the same spot as the Intermodal train before, climbing a two mile one percent grade in notch 8 or what engineers call "run 8". In this case we are pulling hard and our speed has dropped down to 30 mph. The DP unit is providing much needed assistance, otherwise the speed would be around 18 mph. Since the DP unit on this train is set up to do the exact same thing the units on the head-end, we will have to account for this prior to reaching the top of the grade. For now, continue in notch 8.
2. Just prior to reaching the plateau, start dropping notches every 4 or 5 seconds to notch 4 to reduce speed to 20 mph. Our goal is to keep the draft forces at a minimum and keep the train stretched as long as possible.
3. With speed at 20 mph, we need to hit the foot counter (use visual reference) to measure when our DP unit reaches the top of the grade. The top of the grade is the main grade crossing in the center of town. We can not go into dynamic before this occurs, otherwise we could cause a train separation with the dynamic brake active on the DP unit while it is still traveling upgrade. This is the reason for dropping the speed to half of the authorized track speed.
4. Speed will increase as more of the train starts downgrade. Decrease to idle and activate the coast feature if your locomotives are equipped with LokSound Full Throttle. Now you can use the throttle to simulate the increase in speed without the sound of the prime mover increasing.

5. The DP units reach the top and the current speed is up to 35 mph. Now it is time to activate the dynamic brake. Deactivate the coast feature and activate drive hold. With the speed step set, reduce throttle to idle.
6. At the bottom of the grade deactivate the dynamic and increase the throttle to notch 3.
7. Deactivate and reactivate drive hold to lock speed step in notch 3.
8. Begin slowly increasing notches back to notch 8. Speed will begin to slow as more of the train starts climbing the next grade.

Conclusion

This completes the operating manual for the ProtoThrottle. With the information above and suggestions how to operate your new ProtoThrottle like a pro, you are well on your way to becoming a qualified locomotive engineer. Have fun and remember the railroaders motto...

SAFETY FIRST!