STANDARD OPERATING PROCEDURES AND IMPROVEMENTS MADE TO REAL-TIME POWER SYSTEM SIMULATION

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ABSTRACT
Due to system failure or natural calamities, power outages are common. Damage to the electrical system's components might cause this, resulting in costly repairs, outages, and angry consumers. Much energy is depleted at now, and this condition is progressively conveyed from one side or location to another through transmission line. There are a variety of possible transmission line faults. In order to better understand the effects of faults on a transmission line, this article analyzes and investigates these defects. The work here is an approach to the simulation software MATLAB/SIMULINK. We employ over current relays (OCRs) to link a 100Km terco type and analyze their performance in a variety of fault scenarios.

Keywords: Circuit breaker, Current transformers, Medium transmission line, Power system, Voltage transformers

INTRODUCTION

There is no way to protect the power grid against failures, whether such failures result from human error or from a natural calamity. Damage to the power system's components may cause this, and fixing the problem involves a lot of work, including finding the source of the problem and fixing it, before power can be restored to consumers. For a protection system to be effective, it must limit the extent of damage to the system's critical parts, and this may be achieved via several protection strategies for electrical infrastructure [1-3]. Relays based on controller units are used to monitor the power system's performance as a function of voltage and current transducers (VTs) and control transformers (CTs). To ensure the reliability and safety of the protection relays, they must be checked before the substation is turned on. Transmission and distribution in a ring and radial subsystem. The usage of OCRs has grown significantly in recent years. The relays will detect vastly varying currents at various relay sites during the same fault [4, 5]. In order for the faulty stanza to provide sufficient montage ambits unrested immoderate time delay [6–8], the sequence of operation of the relays must be managed in accordance with the coordination techniques. The OCRs provide a significant challenge when trying to optimize ring fed distribution networks. The long-term goal is to increase the reliability of the electrical grid. Setting the relay's time dial (TDs) and pickup current (Ipu) are key to coordinating [9]. In order to choose and create the most effective safety apparatus, fault analysis may be of great help. Due to the large value of triple line fault current relative to other fault current, the C.B. and its ratings must be verified in the event of a triple line fault. Analysis of power system faults (both balanced and unbalanced) is the focus of this work. Using the simulation types provided by Matlab [10-12].

LITERATURE REVIEW

The most common kind of defect was researched by Maiji and Ghosh [2], and it turns out that it happens rather seldom. This high current is discovered via a balanced short-circuit calculation. This article presents the use of MATLAB/SIMULINK for modeling and simulating an over current relay. The proposed model provides striking language for explaining how an over current relay operates. Claims are made that these models provide useful means of elucidating the role of the over current relay in a variety of operational contexts. This article might also serve as a guide to construct homologous relay models and benchmark performance, thanks to the methodical unfolding diction of model creation and deportment analysis. The relay is lucky in that it is sensitive. In order to save primary supply like backup protection and prevent multifunction, Akhikpemelo, Evbogbai, and Okundamiya [3] investigated the impact of relays in the transmission line. The MATLAB GUI model is used to determine the amount of time a relay is on for. They arrived to the conclusion that simulation results may be used to acquire a precise coordination of the different properties of OCRs. The paper's goal is to use Matlab/Simulink-based OCR modulation and transmission line modeling. Matlab/Simulink is chosen on the basis of its efficacy in simulating power- system components, as determined by the results achieved using the software.

2. VARIATIONS AND CATEGORIES

In a well-balanced power system, each component carries the same load. The bus potential and the load current, within the limitations indicated, are considered to be normal. The inability to get normal current flow via the circuit is what constitutes a defect. When there is short or low impedance between phases or between phases and ground [13–17]. There will be a short circuit, which is categorized as [18] in the circuit fault classification system:

- Defects in symmetry.
- Deviations from symmetry

Defects in symmetry

All phases in such devices are either connected directly to the ground or to one another, creating a short circuit. The existence of these flaws is seen as a balanced scenario, since they provide the impression that the system is still symmetrical [19, 20]. Since maximum current faults are among the most dangerous types, it is necessary to do calculations for the balanced short circuit situation in order to determine these currents.

Deviations from symmetry

Only one or two phases were present in an asymmetrical fault. The defects of this kind cause the line to become imbalanced. It is common for faults to occur between lines or from a line to the earth. While an unsymmetrical series fault occurs between a phase and ground or phases, an unsymmetrical shunt fault is defined as an imbalance in the line impedances [21–23]. A shunt failure in three stages may be broken down into:

- Single line to ground fault (L-G).
- Double lines faults (L-L).
- Double line to ground fault (L-L-G).
- Triple line fault (L-L-L).
- Triple line to ground fault (L-L-L-G).

3. OVER CURRENT RELAYS (OCRs)

The information that an OCR provides against current is used to check how close the actual measured value is to the target value. This OCR's figurative portrayal of its logic is shown in (). (1). Relays are designed to transmit a trip signal to the C.B. and open their contact to disjoint the protected device when the input current value exceeds the littleness value. The condition for this scenario is known as fault pickup and occurs when the relay detects an issue. The relay may immediately send out a trip signal once it detects the problem. You may set it to trip immediately (overcurrent relay) or bid for a certain amount of time (time over current case) [24, 25].

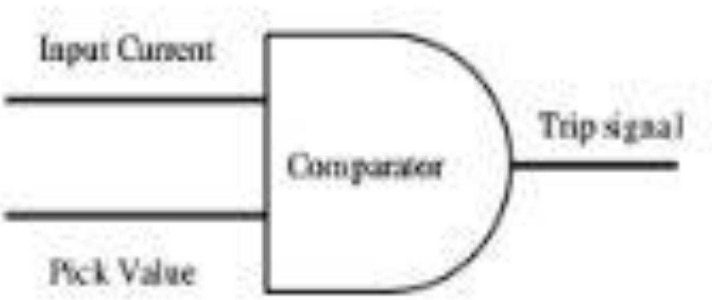

Figure 1: Logical exemplification of Over-Current Relay

1-Based on their functionality, OCRs may be broken down into three distinct groups [2, 3]:

2-First, there are instantaneous OCRs, which, upon detecting a defect, send a trip reinstatement signal to the C.B. immediately.

3-These sorts of backup protection relays, known as "definite time overcurrent relays," are provided free of charge by charitable organizations. The remoteness of the fault will increase after a certain amount of time if the distance relay does not report the event to the C.B.

4-If there is a delay, the OCR will send a trip to the C.B. using an IDMT OCR. The inverse time attribute is a unique feature of these relays. These relays' operating time is inversely proportional to the fault current, therefore they may be categorized according to a broad range of fault currents and running times. Operation time is set by OCRs based on their individual features and related factors.

4.OVER CURRENT RELAY ALGORITHM

Overcurrent protection for transmission lines is shown in Figure (2); an operational operator is employed to make comparisons between the reference current and the fault current. The setting value is compared to the fault current value; if the fault current value is higher, a trip signal is sent to the (C.B.), which then shuts down the transmission line.

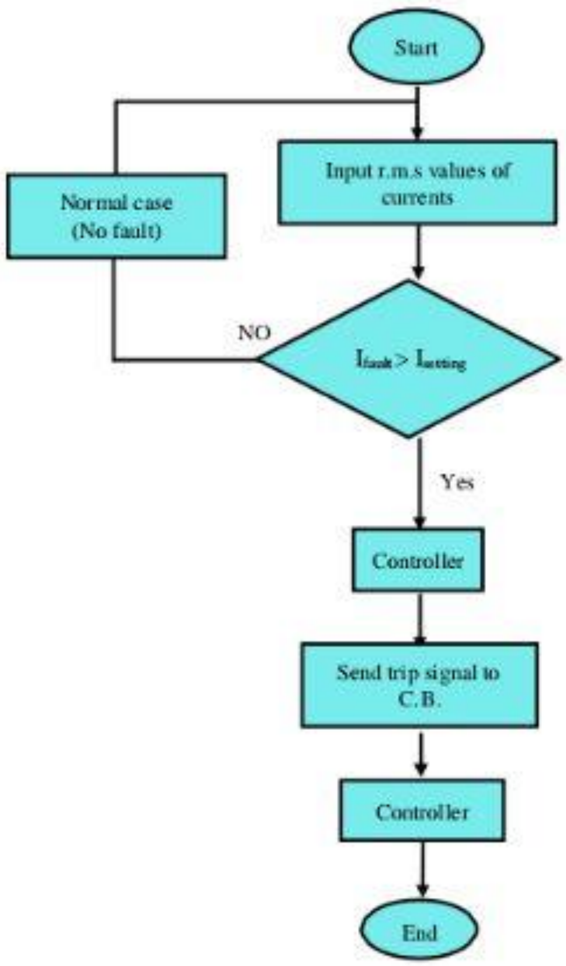

Figure 2: Flow chart of overcurrent protection

5. MODELING AND SIMULATION

The settings for the power system's relays are shown in Table.1. Full-load current calculation is used to determine CT ratio. Earth fault is naturally set lower than the current premium at full load, while phase fault is setting above than the current premium at full load, in order to locate the high impedance fault at ground fault. The line has a length of 100 km and the power system parameters for phase and earth faults are variables.

Table1: Network and relay setting parameters

Parameters	Values
Source Short Circuit Level (MVA)	110
Source VLL (KV)	230
Line Length (Km)	100
Sequence Resistance, R (Ω)	2.20
Sequence Inductance, L (mH)	25
Sequence Capacitance, C (µF)	2.5
Line VLL (V)	400
Network Frequency (Hz)	50

Description of model

All possible failure scenarios are put through their paces on the Multifunctional relay prototype. Transmission line used in this study, manufactured by terco and designated MV2221, is seen in Figure 1. (3). The transmission lines are 100 kilometers in length and operate at 50 kilovolts. As shown in Figure 3, the relay and network models are initialized in the MATLAB/Simulink software package. The selected network is a simplification of an artless spur transmission line girded to a three-phase power supply on one side and a load on the other. The phases of the currents are represented by blue, yellow, and red lines in the simulation model. A residual current flows to the earth when a ground fault occurs, but not when a phase to phase fault occurs. The 230KV/100KM terco model used in this study is shown in Figure 3.

Figure 3: MV2221 Line Model

6. EXPERIMENTAL AND SIMULATION RESULTS

Station (generation station) and load centers are linked by additional high voltage wires. In cases when several hundred kilometers separate the generating legs from the load center. Given that 83–86 percent of power outages are caused by problems with overhead lines, transmission line protection is a major concern in the electrical power system. Matlab/protective Simulink's circuit design for OCRs is shown in Figure 4.

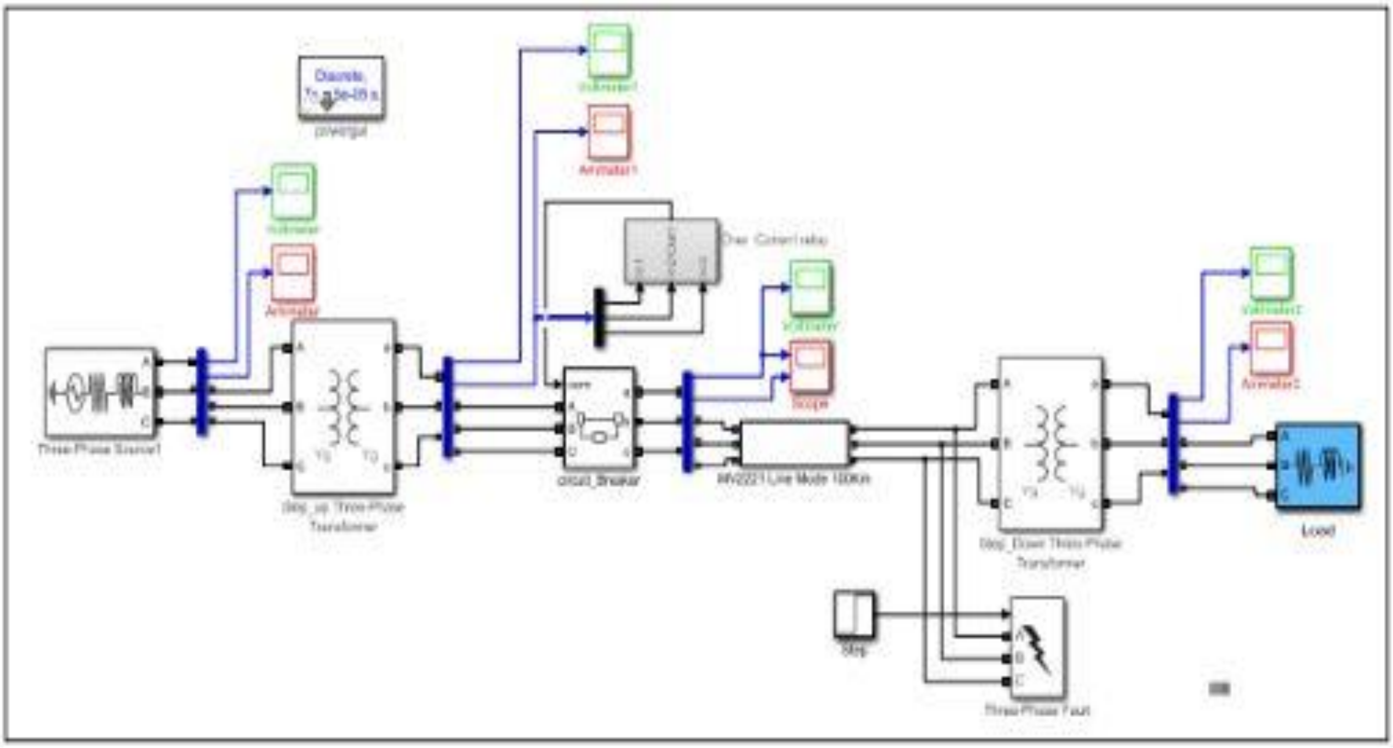

Figure 4: Matlab Simulink model of used model

6.1 Normal Case (Without Fault):

If there is no problem with a medium transmission line, the resultant signal will be perfectly normal, with a current value that is evenly distributed, as shown in Figure 1. (5). we will use these energies as our starting point standard. When there is even a little variation in these characteristics, the phase associated with that instance is deemed to be faulty.

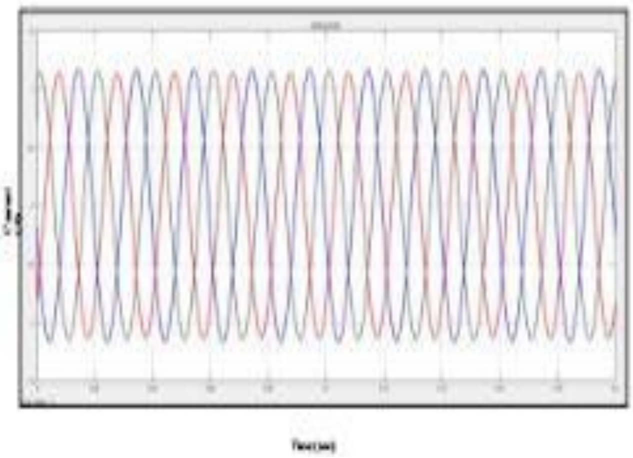

Figure 5: Current signal without fault related

6.2. L-G Fault

The fault from the line to the ground is shown in Figure 6 (A- G, B-G, C-G). In an A-G fault system, the (A) phase signal is the most transitory or has the highest peak value. In the (A-G) fault system, there is a variation in the energy coefficients associated with each phase and ground. When one phase is shorted to ground and the fault is detected at the fault site, a line to ground fault is simulated. Figure depicts the waveforms that result from the circuit's operation (7).

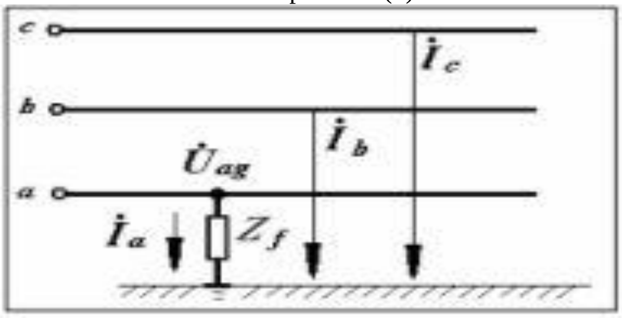

Figure 6: Single line to ground fault

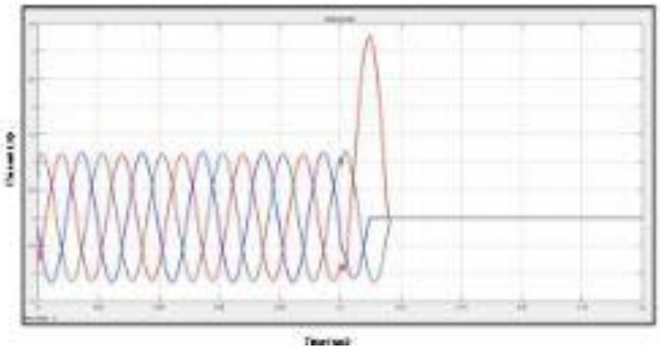

Figure 7: Current signal of single line-to-ground fault (A-G)

6.3. L-L-G Fault

Regarding the A-G rupture. A, B, and zero signals all have larger transient faults compared to the other phases. The estimated coefficients and the dependent seamed energy in each phase relative to ground are shown. As can be seen in figure, the AB-G fault system modifies the energy seamed with all analyses and coefficients of A, B phases, and ground (8). The current waveforms of a double line to ground fault are shown in Figure (9).

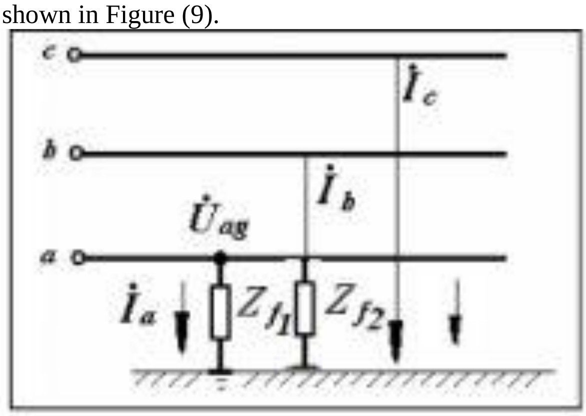

Figure 8: Double line to ground fault

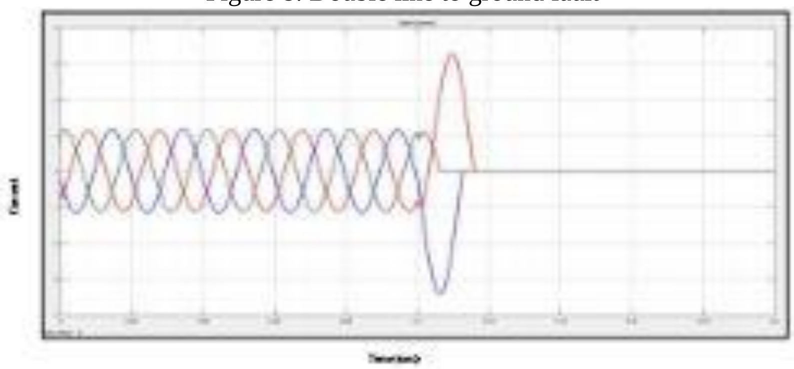

Figure 9: Current signal of double line to ground fault (A-B-G)

6.4 LLL-G Fault

Once three phases are shorted to ground, a triple line to ground fault occurs. When the amplitude of the line current fault is greater than the ordinary input current, as shown in figure (10), a triple line to ground fault occurs (11). As a result, the output waveforms revealed a rise in the value of the current from three phases to ground.

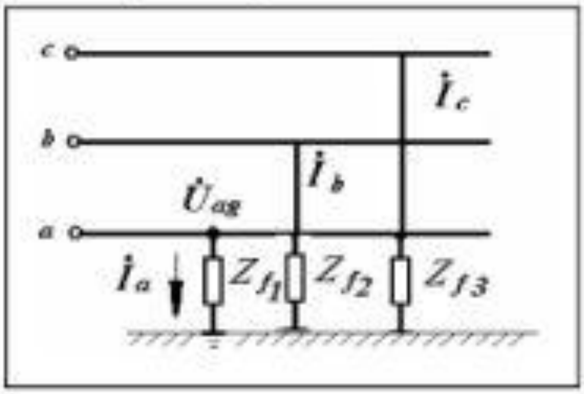

Figure 10: Triple line to ground fault

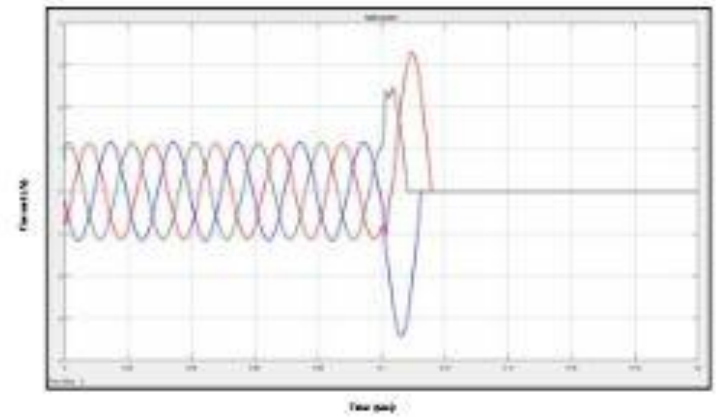

Figure 11: Current signal of three phase to ground fault (A-B-C-G)

Line to Line Fault (A-B)

Current output waveforms seen in Figure (12) when two phases are shorted together without ground and the fault spot is detected.

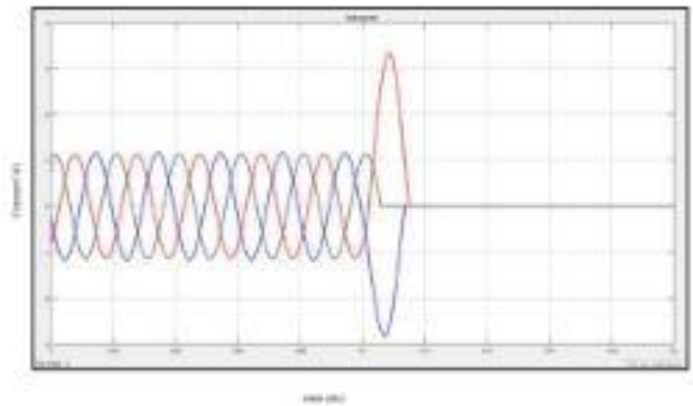

Figure 12: Current signal of double Line Fault (A-B)

Triple-Line Fault (A-B-C)

The waveforms of the current output are shown in Figure (13) when three phases are shorted together without ground and the fault spot has been detected.

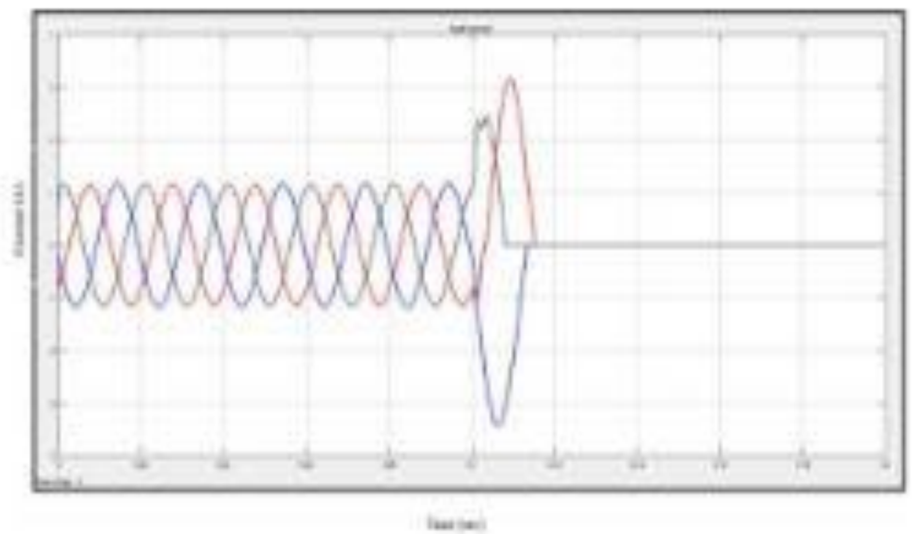

Figure 13: Current signal of three Phase Fault (A-B-C)

7. CONCLUSION

Waveforms of currents for each kind of fault acquired were seemed appositeness to factual situations, and assumptions on each case likewise showed appositeness to standard rater in a MATLAB/SIMULINK simulation of a (100Km) transmission line (terco type) using actual (real) parameters. Standard OCR is modeled and simulated with flying colors in MATLAB/SIMULINK. To mimic any kind of relay, this software claims to be the best choice. The length of time required to run a simulation is proportional to the model's complexity. Complex models may need more time for simulation; therefore picking the right simulation solution is important. This article's chosen model is easily adaptable to different types of curves, including ordinary over current types.

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