

# SMS based Load Shedding Period Control System

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## ABSTRACT

Energy is one of the basic requirements in modern civilization, without which various indispensable applications will bind to a standstill. It is really not possible to measure the actual enormity of the function that energy has accomplished in connection with human advancement. As energy plays such a significant role in our day-to-day life, hence we should confer a precedence to accumulate it by the use of load shedding. Conventional methods of load shedding systems are too slow to calculate efficiently the accurate amount of load to be shed. This consequences either excessive or insufficient load reduction. In latest years, load shedding systems have been carried out using conventional under-frequency relay and/or breaker interlocks schemes incorporated with Programmable Logic Controllers to give an innovative glance to an obsolete load preservation methodology. In true sense, period of load shedding can be controlled with a computerized power management system where rapid and optimal load management can be done. Again, the Computerized Load Shedding Control System can now be extended and it can be controlled by a SMS based system. This paper demonstrates the need for a modern load shedding scheme and introduces the idea of developing a SMS based procedure for controlling the load-shedding system where manual work will be minimized by selecting the feeder, substation and duration of shedding time by the user by sending SMS. Simulation results', using the above proposed model, verifies the suitability of choosing such a SMS based automated load shedding period control system.

## Keywords

Load Shedding; Energy; Electricity; SMS Based System; Substation; Feeder; Shedding Time.

## 1. INTRODUCTION

Present-day civilization of the world is fully enriched with latest technologies which are making our lives comfortable and machine depended. But these entire technological products around us are greatly utilizing electric power and most of the world is not having enough electric power to meet our requirements. Thus, we necessitate the suitable distribution of electric power. Load shading [1] is an intentionally-engineered electrical power [2] outage where electricity delivery is stopped for non-overlapping periods of time over geographical regions. For manually maintaining Load shading periods, some man power may be employed or by using computer it can be controlled efficiently. Detaching of power is done to minimize the load being consumed by the society through several substations which are connected to the main power station [3].

And the main station instructs the sub-stations to cut some of the feeders for a certain period of time & thus the shedding procedure continues. In recent years, conventional under frequency and PLC-based [4] load shedding schemes have been integrated with computerized power management systems to provide an “automated” load shedding system. It can provide faster and optimal load relief by utilizing actual operating conditions and knowledge of past system disturbances. The main theme behind the proposed method is to replace the computerized procedure for controlling the load-shedding time period [5] by a SMS based system [6] where the shedding management process, manual work may be minimized in a systematic way. As we all know that any low cost mobile phone is capable of sending text messages, hence this SMS based shedding scheme will be very cheap and easy to operate and having fewer complexities with a proper user friendly interface provided by the system.

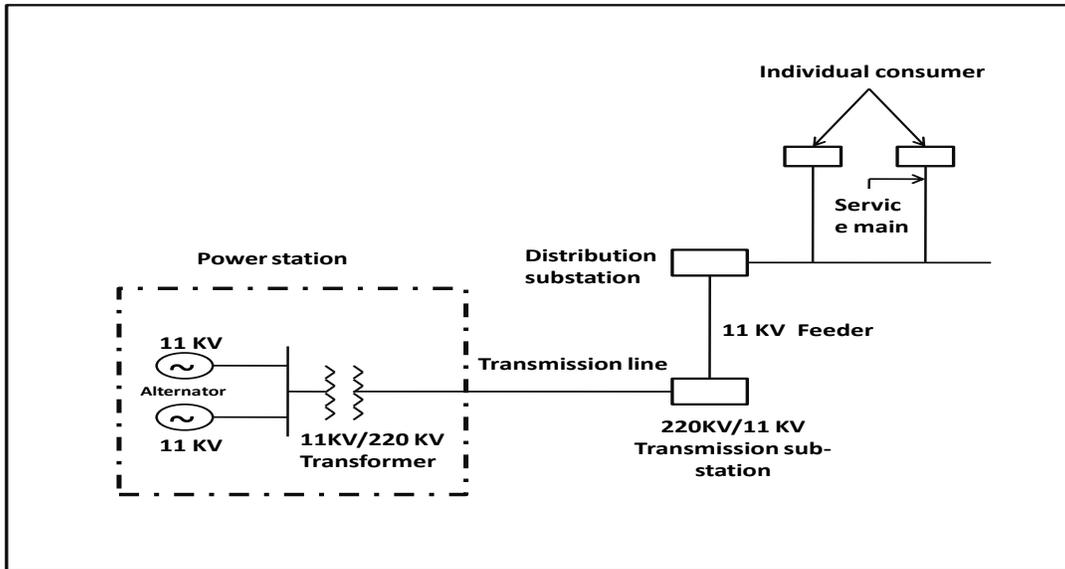
## 2. EXISTING LOAD SHEDDING SCHEDULE MANAGEMENT

The purpose of an electric power system is to attach the power stations to the consumers' loads by means of interconnected system of transmission & distribution networks [7]. Therefore an electrical power system consists of three principal components:

1. Power Station
2. Transmission Lines and
3. Distribution Systems.

In the shedding process, under a main power station there are several sub-stations who perform power-cut for a certain period of time to control the shortage of electrical energy used by the people of the locality. In manual system of load shedding, workers form the electrical authority are engaged in the substations who attend the calls and directions from the main power station & as per the upper levels direction, power system of some area are manually cut down by the workers for a period of time. And after the completion of those areas' shedding some other areas are cut-off. In this way the shortage of electrical energy is covered up by the electrical authority.

There were several conventional implementation of the above mentioned manual load shedding scheme. This section depicts a review of a number of load shedding systems that have been developed earlier.



**Fig. 1: Electric flow from power station to consumer**

## 2.1 Breaker Interlock Scheme

The simplest system [8] carried out for load shedding control had a source breaker, which would be interlocked via hardwired or remote signals to a set of load breakers that have been pre-selected to trip. When a generator breaker or a grid connection is lost for any reason, signals are automatically sent to load breakers to open. This system is difficult to change load priority since the actions for load shedding are hardwired and amount of load shedding is calculated for the worst-case scenario.

## 2.2 Under Frequency Relay Scheme

Frequency relays [9] do not detect disturbances but react to the disturbances. They detect either a rapid change in frequency or gradual frequency deterioration and initiate staged operation of interlocked breakers. When the first stage is reached, the relay waits a predetermined amount of time, to avoid nuisance tripping, and then trips one or more load breakers. This is done to allow the frequency to recover. If the frequency continues to decay, the relay will wait for the next stage to be reached and after an additional time delay, opens other load breakers. This system has a slow response time and also incorrect load may be dropped causing undesirable shedding

## 2.3 PLC Based Scheme

In PLC-based load shedding scheme [10], load shedding is initiated based on the system frequency deviations and/or other triggers. The circuit breaker tripping can be programmed based on the system loading, available generation, and other specific logics. Each subsystem is equipped with a PLC that is programmed to shed a preset sequence of loads. This static sequence is continued until the frequency returns to a normal condition. Modification of the logic requires changing of the latter-logics that are programmed in the PLCs. The system-wide operating conditions are often missing from the PLC's decision-making process resulting in insufficient or excessive load

shedding. In addition, the load shedding systems response time during transient disturbances is often too long requiring for even more load to be dropped.

Therefore, our paper focuses on developing a SMS based procedure for controlling the load-shedding system which can now be extended computerized Load shedding system controlled by remote communication through SMS.

## 3. PROPOSED SYSTEM ARCHITECTURE

Improvement in computational technologies has opened the door for fast Load Shedding Controller (LSC) designs with low cost, expediency, scalability and remote access capability. This paper deals with designing such a computerized LSC which will reduce manual effort for controlling the load shedding time interlude in a systematic way by sending SMS. For this, the following requirements are there:

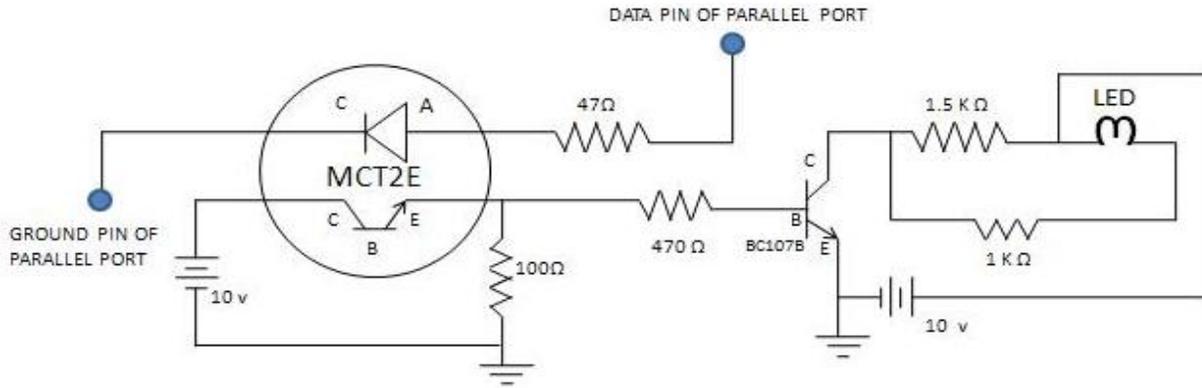
### 3.1 Hardware Components

#### 3.1.1 The proposed system needs the following hardware components:

- i) Photo transistor Optocouplers MCT2E
- ii) BC107B NPN Transistor
- iii) Resistor
- iv) Protective relay mechanism & Manometer:

The relay circuit connection may be divided into three parts: First part is a primary winding of a current transformer which is connected in series with the line to be protected.

Second part consists a secondary winding of C.T. & the relay coil. Third part is the tripping circuit [11] which may be either A.C. or D.C. It consists of a source of supply, the trip coil of the circuit breaker & the relay stationary contacts.



**Fig. 2: A Model Circuit diagram for proposed system**

When the short circuit occurs at point on the transmission line, the current flowing in the line increases to a enormous value resulting a heavy current flow through the relay coil, causing the relay to operate by closing its contacts. This in turn closes the trip circuit of the breaker, making the circuit breaker open & isolating the faulty section from the rest of the system. Thus the relay ensures the safety of the circuit equipment from damage.

### 3.2 Software Components

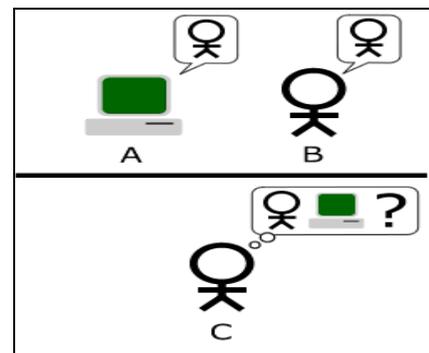
#### 3.2.1 Introduction to the SMS based system:

SMS, stands for “Short Message Service”, is a technology that enables the sending and receiving of messages between mobile phones. SMS first appeared in Europe in 1992. It was included in the GSM (Global System for Mobile Communications) [12] standards right at the beginning. Later it was ported to wireless technologies like CDMA and TDMA. As suggested by the name "Short Message Service", one SMS can contain at most 140 bytes or 160 bytes (in case of 7-bit character encoding) of data. SMS can be sending in two modes: i) Text mode ii) PDU mode. Here SMS is send in Protocol Data Unit mode.

#### 3.2.2 Turing Test:

The **Turing test** is a test of a machine's ability to exhibit intelligent behavior. A human judge engages in a natural language conversation with one human and one machine, each emulating human responses. All participants are separated from one another. If the judge cannot reliably tell the machine from the human, the machine is said to have passed the test. In order to test the machine's intelligence rather than its ability to render words into audio, the conversation is limited to a text-only channel such as a computer keyboard and screen.

To make the system easier the proposed model tries an implementation of Turing test. As in the Turing Test [13] the user find it difficult to understand whether he is communicating with an human or computer, same in case of the proposed system in the paper, the user will thought that he is actually communicating with another person through SMS, unaware of the fact that actually the system gets his request message, parses it and based on some computation sends him back the result of his query, all in an automated fashion.



**Fig. 3: User communication with system**

#### 3.2.3 How to send/receive SMS?:

In general, there are two ways to send SMS from a computer / PC to a mobile phone:

1. Connect a mobile phone or GSM/GPRS modem [14] to a computer / PC. Then use the computer / PC and AT commands to instruct the mobile phone or GSM/GPRS modem to send SMS messages.
2. Connect the computer / PC to the SMS center (SMSC) or SMS gateway of a wireless carrier or SMS service provider. Then send SMS messages using a protocol / interface supported by the SMSC or SMS gateway.

In this paper, the first concept is used and only with the help of mobile phone SMS is send from PC.

#### 3.2.4 Sending SMS from PC using mobile:

In the proposed model in this paper, the mobile phone is connected through a USB cable. After connecting a mobile phone to a computer, it can be controlled by sending instructions to the mobile.



**Fig. 4 Communication between mobile and system through SMS**

The instructions used for controlling the mobile phone are called AT Commands [15]. Mobile phones support a common set of standard AT commands and in addition mobile phones also support an extended set of AT commands which are used to control the sending and receiving of SMS.

Below shows a simple example that is used as AT commands and the HyperTerminal program of Microsoft Windows to send an SMS. The lines in bold are the command lines that should be entered in HyperTerminal [16]. The other lines are responses returned from the mobile phone.

```
AT
OK
AT+CMGF=1
OK
AT+CMGW="+85291234567"
> A simple demo of SMS text messaging.
+CMGW: 1
OK
AT+CMSS=1
+CMSS: 20
OK
```

Here is a small description of what is done in the above example:

**Line 1:** "AT" is sent to the mobile to test the connection. The mobile sends back the result code "OK", which means the connection between the HyperTerminal program and the mobile works fine.

**Line 3:** "AT command + CMGF" is used to instruct the mobile to operate in SMS text mode. The result code "OK" is returned which indicates the command line has been executed successfully.

If the result code "ERROR" is returned, it is likely that the mobile does not support the SMS text mode. To confirm, type "AT+CMGF=?" in the HyperTerminal program. If the response is "+CMGF: (0,1)" (0=PDU mode and 1=text mode), then SMS text mode is supported. If the response is "+CMGF: (0)", then SMS text mode is not supported.

**Line 5 and 6:** "AT command +CMGW" is used to write an SMS text message to the message storage of the mobile. "+85291234567" is the recipient mobile phone number. After typing the recipient mobile phone number, 'Enter' button of the keyboard has to be pressed. The mobile will then return a prompt ">" and typing the SMS text can be started as "A simple demo of SMS text messaging." When typing is finished, press "Ctrl+z" of the keyboard.

**Line 7:** "+CMGW: 1" tells us that the index assigned to the SMS text message is 1. It indicates the location of the SMS text message in the message storage.

**Line 9:** "AT command +CMSS" is used to send the SMS text message from the message storage of the mobile. "1" is the index of the SMS text message obtained from line 7.

**Line 10:** "+CMSS: 20" tells us that the reference number assigned to the SMS text message is 20. And the result code "OK" indicates the execution of the AT command +CMSS is successful.

### 3.2.5 Using a PC to receive SMS through mobile:

Below shows a simple example that demonstrates how to use AT commands and the HyperTerminal program of Microsoft Windows to read SMS text messages received by a GSM / GPRS modem or mobile phone.

```
AT
OK
AT+CMGF=1
OK
AT+CMGL="ALL"
+CMGL: 1,"REC READ","+85291234567","06/11/11,
00:30:29+32"
Hello, welcome to SMS tutorial.
+CMGL: 2,"REC READ","+85291234567","06/11/11,
00:32:20+32"
>A simple demo of SMS text messaging.
OK
```

Here is a description of what is done in the above example:

**Line 5-9:** The AT command +CMGL is used to list all SMS text messages in the message storage of the mobile. There are two SMS text messages in the message storage: "Hello, welcome to SMS tutorial." and "A simple demo of SMS text messaging." "+85291234567" is the sender mobile phone number. "06/11/11, 00:30:29+32" and "06/11/11, 00:32:20+32" tell us when the SMS text messages were received by the SMS Centre. "+32" is the time zone. Note that the unit is a quarter of an hour. So, +32 means GMT+8 hours, since 32 quarters of an hour = 8 hours. "REC READ" indicates both of the SMS text messages have been read before.

**Line 11:** The result code "OK" indicates the execution of the AT command +CMGL is successful.

### 3.3 How the proposed system works:

For the successive execution of the proposed system, some step by step procedure or algorithm is used to incorporate the load shedding scheme. This is as following:

Step – 1: Select Substation from the grid present.

Step – 2: Select the feeder from the substation equipment list.

Step – 3: Make a choice of whether to turn it on or off.

Step – 4: For a particular feeder, the choice of switching it on/off after specified duration is also possible.

Step – 5: Make final confirmation on the choice made.

In case of SMS based system in the above algorithms, we can use some abbreviations representing the name of the Substations, feeder or grid. Because we all know that the text SMS will support only 160 characters in a single SMS. Therefore, one can select the abbreviated names for a substation, followed by grid and then the choice for turning it “ON” or “OFF”. For simplicity, one can use the SMS as following:

<URT> <grd1> <ON> or <KLT><grd2> <OFF>

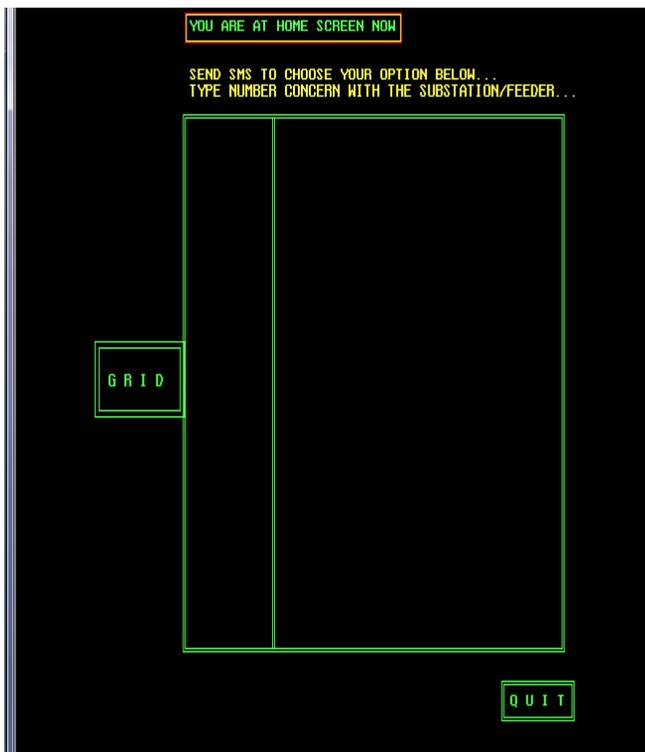
These three fields in a SMS will be sent to the server, then SMS will be parsed and analyzed by the server and reply will be given back to ensure that selected portion is turned ON or OFF. Also, one can send the duration along with substation and grid in terms of minutes to make a specific duration of power cut.

For e.g. <KLT><gr2><OFF><30> will make a power cut of 30 minutes to the said location.

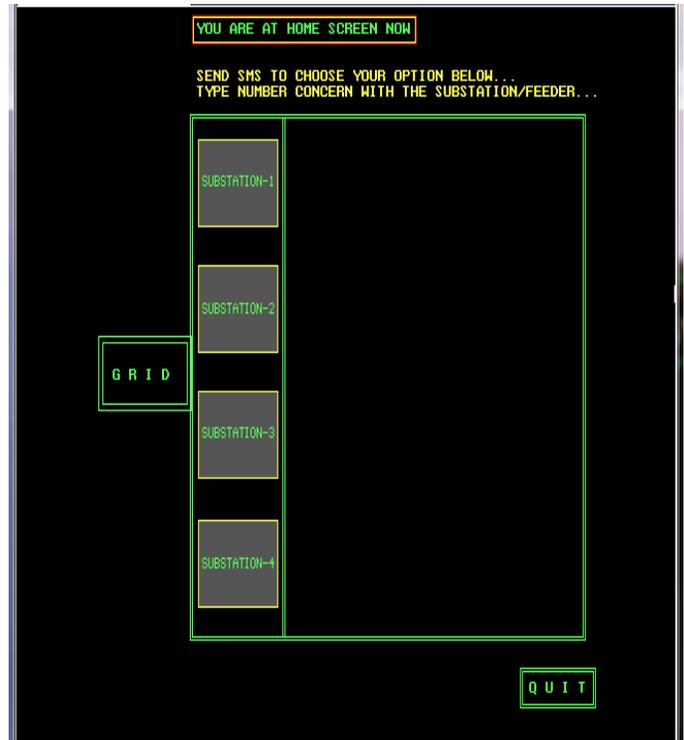
#### 4. SIMULATION USED TO DEPICT THE SCHEME

Below some of the snapshots are given from the SMS based Load Shedding Control System Simulator.

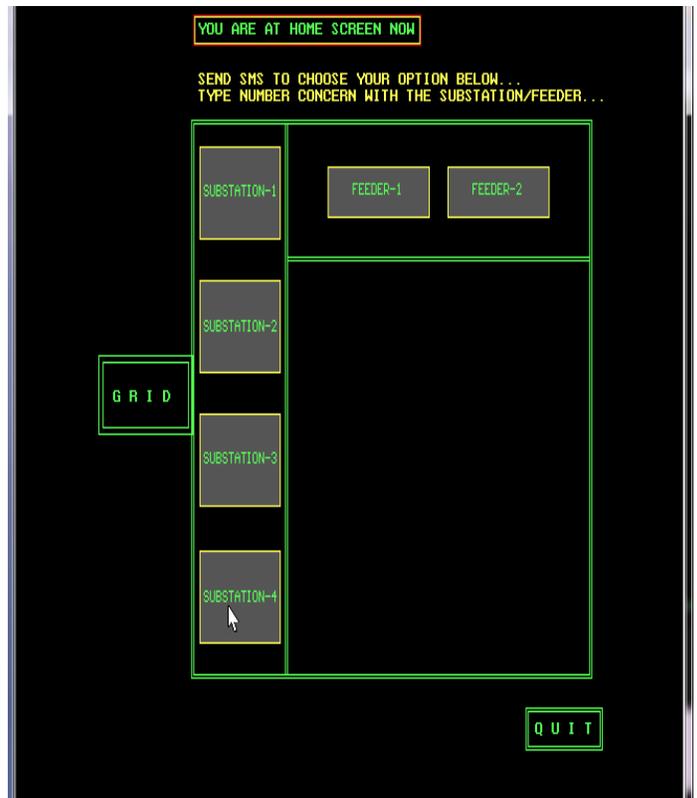
The electrical circuit arrangements, which are being done, can be attached with the parallel port of the computer and with the help of C program the Electrical Circuit can be controlled by the Computer [17]. Therefore, once input data (feeder, substation, time period of power cut etc.) will be selected with the help of programming interface, automatically the whole setup will be controlled by the software written in C language. The program will then control the whole load shedding scheme.



**Fig. 5: Selection of Input**



**Fig. 6: Selection of Substation**



**Fig. 7: Selection of Feeder**

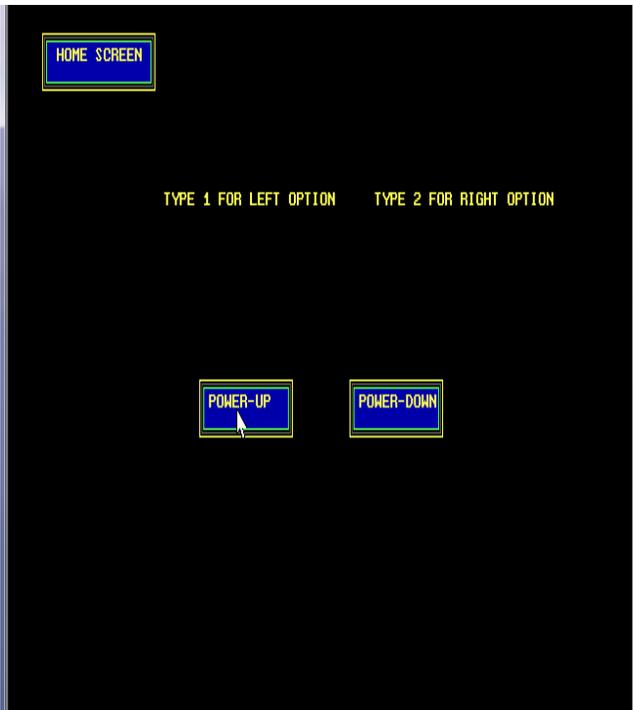


Fig. 8: Selection of Power ON/OFF

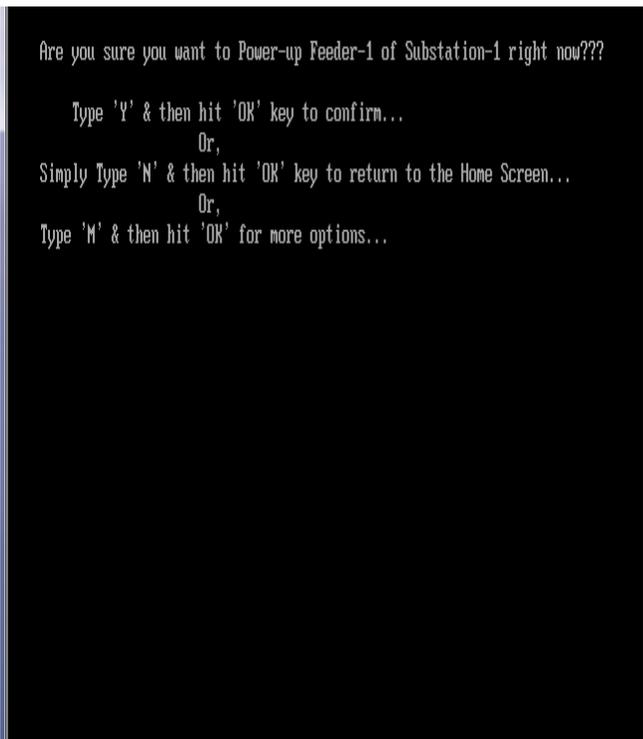


Fig. 9: Confirmation of Power ON/OFF

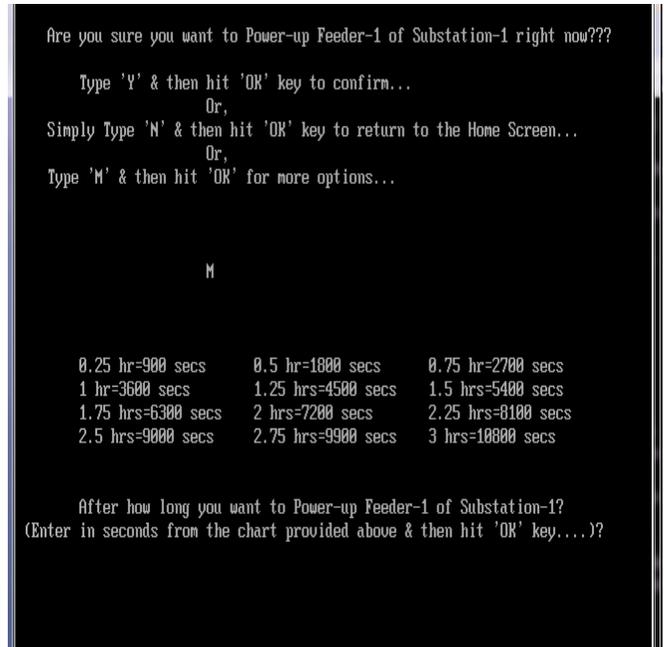


Fig. 10: Selection of Time Period of Power OFF

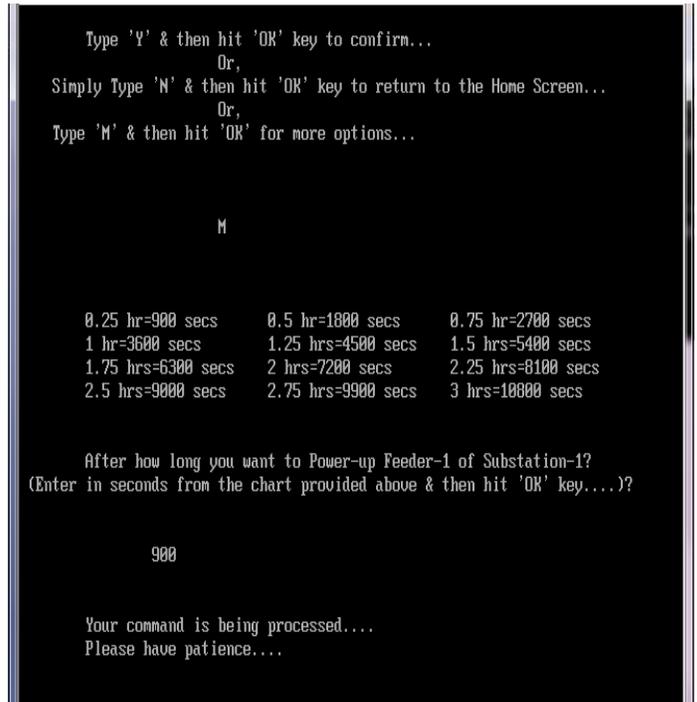


Fig. 11: Screen after entering the required time.

## 5. CONCLUSION AND FUTURE SCOPE

Due to the insufficiency of adequate power supply, electrical authority used to shut power supply in different urban and rural areas for proper distribution. To maintain this power shut down periods in several areas at peak hours requires enough manpower and continuous observations. The proposed system along with remote communication with sms will be running automatically and minimized a huge amount of manual work and enhance efficiency to the existing manual system.

As the power shut down system is highly sensitive and under strict control of the authority, the proposed system can be extended with security implementation. To communicate through sms and operate the system user will be asked for ID and password. For enhancing the security the system will be only operational with proper authentication. From server side one administrator will maintain ID and passwords to designated employees.

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