Spring City
Capital Facilities Plan

June 2020

Intermountain Consumer
Professional Engineers, Inc.
1145 East South Union Avenue
Midvale, Utah 84047
(801) 255-1111

TABLE OF CONTENTS

<u>Section – Contents</u> **<u>Page</u>**

INTRODUCTION AND SUMMARY

Intermountain Consumer Professional Engineers ("ICPE") has prepared this electrical system study and Capital Facilities Plan ("CFP") at the request of Spring City. The intent of the plan is to anticipate future demand for electricity and evaluate the capacity of the City's electrical system to supply it. Improvements to the system are proposed to insure that capacity is in place to supply power to customers when needed. Where appropriate, improvements to safety, reliability, and efficiency of the electric system are recommended. This report has been prepared to provide Spring City information for budgeting and planning purposes. Detailed design work is not included as part of this study.

The general findings and recommendations of the CFP are presented in the proposed improvements section of this report. The proposed improvements section lists major projects that are proposed in the plan, the general estimated timeframe when these projects should be completed, and the estimated cost of the projects in 2020 dollars. The actual timeframe may be sooner or later depending on load growth experienced in a given area.

System Model and Assumptions

This CFP contains results of load flow analysis of the Spring City electrical system. The system load flows provide insight on 12.47 kV distribution circuit loading, 4.16 kV distribution circuit loading and system voltage drop. The study includes analyzing N-1 outage conditions. An N-1 outage condition is the loss of a major system component such as loss of a recloser or main line section. Spring city's 12.47 kV and 4.16 kV circuits were studied.

To perform load flow analysis a system computer model was developed. System model development and analysis were performed on Paladin DesignBase 4.0 software. System modeling data was developed from data provided by Spring City. Circuit models are based on the assumption that provided GIS circuit maps and data (conductor sizes, circuit configurations, line lengths, etc.) are reflective of actual field conditions.

Distribution System

This study considers the electrical load growth within the Spring City Power service area. Spring City Power serves the town of Spring City and the surrounding area. Spring City currently serves approximately 570 customers. It is projected that 10 new homes will be connected to the electrical system each year for the next five years. Approximately 326 kW of new load is projected to be added to the Spring City electrical system over the next five years. The new load is expected to include 19 large (5 acre) homes in a new subdivision up Canal Canyon. Each home in this subdivision is estimated at 9kW for a total of 171 kW. Another 31 average size homes estimated at 5 kW each for a total of 155 kW are also expected. These homes will be spread out though out the city.

Spring City receives its power from RMP's Pine Creek substation. Spring City Power owns and maintains their distribution system. The distribution system consists of two circuits. One is at 12.47 kV and the other is at 4.16 kV. The city is in the process of converting the 4.16 kV circuit to 12.47 kV. This includes upgrading insulators, cutouts, transformers, and arrestors to 12.47 kV. The current plan is to finish converting the 4.16 kV circuit to 12.47 kV by approximately 2025. The city is currently spending approximately $30,000 per year on the conversion. Over the next five years approximately $150,000 will be spent on the conversion.

The reason Spring City is converting to 12.47 kV is to increase the capacity of the system to allow for future growth. It also reduces voltage drop on the system and reduces system losses. It is recommended that when future lines are installed that they be a minimum of 1/0 ACSR for tap lines and a minimum of 4/0 ACSR for main lines. Existing lines in many cases are smaller than this. In the future it may be necessary to upgrade them due to load growth, but this is not required over the next five years.

Spring City owns and operates one 300 kW 4.16 kV 600 RPM generator that is located west of Spring City. It currently connects to the 4.16 kV circuit and feeds into 400 South. As part of the 4.16 kV to 12.47 kV conversion the line the generator connects to is being changed. The new line will connect to 100 South and will be connected to the 12.47 kV circuit. The generator typically is not able to generate to its full rating. Generating 100 kW to 200 kW of power is more typical.

During N-1 contingencies such as loss of a transformer, recloser, or main line segment it becomes necessary to be able to back up circuits with adjacent circuits. Load flows indicate that the existing system is unable to do this. The city consists of two circuits each at a different voltage level and the circuits are radially fed. Once the conversion of the entire system to 12.47 kV is completed the electrical system will be radially fed to a normally open point that can be closed if necessary. This allows load to be able to be fed from more than one location in the event of a recloser or line outage or for system maintenance. This flexibility increases reliability of the system.

Fuse Coordination

Distribution fuses sizes for the existing 12.47 kV circuit were evaluated to ensure coordination with the existing 12.47 kV recloser. Overhead distribution fuses are type T. Recommended fuse sizes for the existing 12.47 kV circuit are shown in the following table. The recommended maximum fuse size is 30T. This fuse size should be used at branches to the main line. Fuses that are in the main line should be changed to slugs. Having fuses in the main line will limit the current carrying capacity of the circuit. Putting slugs in these locations will still allow them to be used when necessary for switching.

Fuses that are currently part of the 4.16 kV circuit have been labeled as future in the table below since their size shouldn't be changed until they are converted to 12.47 kV. It has been assumed that the 4.16 kV fused cutouts will be replaced with 12.47 kV fused cutouts located at the same location. It has also been assumed that overcurrent settings for the new 12.47 kV recloser that will replace the 4.16 kV recloser will be similar to the existing 12.47 kV recloser. Sizes shown can be used once the conversion to 12.47 kV is complete.

One switch located at 150 South 300 East is recommended to be added. This will become the new normally open point between the two circuits once the conversion to 12.47 kV is complete.

Fuse Location	Voltage and Pole	Recommended Size
300 East 500 North	12.47 kV Pole 87 (North-South Line)	Slug
300 East 100 South	12.47 kV Pole 297 (East-West Line)	30T
150 South 200 East (New Switch)	12.47 kV Pole 494 (North-South line)	-
300 East 400 South (Future)	12.47 kV Pole 794 (East-West Line)	30T
500 North Main Street (Future)	12.47 kV Pole 418 (North-South Line)	Slug
100 South Main Street (Future)	12.47 kV Pole 465 (North-South Line)	Slug
400 South Main Street (Future)	12.47 kV Pole 824 (North-South line)	Slug
400 South Main Street (Future)	12.47 kV Pole 824 (East-West line)	30T

Power Factor

Power factor at a few locations around town where load metering was recently performed was provided and the following table lists average power factor by location. Based on these readings power factor is fairly good throughout the system and no projects to improve the power factor are recommended at this time. There is one spot along Main Street that shows low power factor. This is along the 4.16 kV line that connects to the generator. It has been indicated by the City that the power factor at the generator is always lagging. The line feeding the generator is being changed as part of the conversion and will feed a different area of the city at 12.47 kV. It is also noted that load losses will decrease once the 4.16 kV circuit is converted to 12.47 kV. After the entire system is at 12.47 kV it is recommended to re-investigate the power factor to see if power factor corrections are required. The power factor at the UAMPS meter was not provided for this study, but it may be beneficial to verify power factor at the meter in the future.

The city owns a 4.16 kV 120 kVAR cap bank that was originally located at 250 South Main Street. It was taken out of service because it was blowing fuses. If this cap bank were to be re-installed it would help the 4.16 kV line with low power factor, but it could only be temporary since the circuit is being upgraded to 12.47 kV. Also it is unknown why the cap bank was blowing fuses so there may be some unknown issue with it. For these reasons it is not recommended to re-install the cap bank.

Meter Location	700 North 300 East	750 North 300 East	400 North 300 East	300 North 300 East	600 North Main Street	400 South Main Street	700 South 500 East
Power Factor	.95	.97	.97	.96	.77	.99	.99

Residential Solar

Spring city allows solar to be installed on residential homes with a maximum size of 5 kW per home. Solar is currently limited to a total of 50 kW for the whole city, but this limit will probably be increased in the future. The amount of solar that can be added to the system without causing issues is not a simple answer. It depends on several factors including the following. Is it spread out across the system or concentrated in one area? Is it at the start of the distribution circuit, in the middle of the distribution circuit or at the end of the distribution circuit. Is it located on the circuit tied to the generator or on the circuit without the generator? It also depends on the amount of load that is on the circuit.

It is assumed that the residential solar will be spread out on the two circuits instead of concentrated into one area. Without doing specific solar studies, Spring City could consider allowing approximately 15-20% of circuit kW to be fed by solar. Based on current city load levels this would be 150-200 kW of residential solar. For solar levels larger than this the system should be studied. Also, any large solar installations by commercial or industrial customers should be evaluated before they are installed to verify that they will not create electrical issues.

It is important that solar interconnections adhere to the latest applicable version and amendments to IEEE 1547, Standard for Interconnecting Distribution Resources with Electric Power Systems, and to all applicable standards and codes including the National Electrical Safety Code and National Electric Code. Some of the requirements that are necessary in order to prevent adverse effects on the distribution system are listed below.

1. Each solar installation must have an effectively grounded system as defined by the IEEE or must use an inverter that is certified to prevent ground fault overvoltage (GOV). Without proper grounding or the use of a certified inverter, GOV can occur during a ground fault on a distribution line causing damage to equipment connected to the distribution line.

2. Protective relaying must be installed at the solar generation facility which will trip generation off line when a phase-phase or phase-ground fault occurs on the utility distribution line. Protection must be capable of sensing abnormal voltage and frequency, and overcurrent at the utility interconnection.

3. Prior to reconnecting to the distribution system the solar generation shall measure voltage and frequency at the point of interconnection for one minute to verify that they are within normal limits.

4. The solar generator must cease to energize the utility distribution line within 2 seconds of an interruption of the line's utility source. The solar generator must not energize a de-energized utility distribution line. Generally, an island will not be sustained if maximum solar generation combined with other generation connected to the distribution line is less than 33% of minimum load on the line during day light hours.

   Islanding protection may be provided by the inverter or by voltage or frequency relays. Certified testing of this protection is required to confirm solar generation will not sustain an island for more than 2 seconds.

   For larger installations, an evaluation by the utility may be necessary to determine whether protection is required on the distribution system to prevent the adverse effects of unintentional islanding. If the solar generator cannot cease to energize an unintentional island in 2 seconds, facilities must be installed to remotely trip solar generation off line when the source recloser opens. If this is necessary, an optical fiber or radio communication link between the source breaker and solar facility will be required. It this case it may also be necessary to block reclosing at the source recloser.

5. IEEE standards should be followed for voltage, frequency, flicker, and harmonics to prevent adverse effects on the distribution feeder.

SYSTEM LOAD HISTORY AND FORECAST

Load Forecast

Management of an electric utility system requires careful planning. Load forecasts are essential to planning. New facilities must be designed, ordered, and installed in time to meet the needs of new residences and businesses; power resource contracts must be in place to supply growing demand at the most economical rate. In addition, budgetary estimates for new facilities need to be created for both short term and long range financial planning.

Historically the Spring City electrical load growth has been pretty flat. Over the next five years it is anticipated that it will grow more consistently and that most of the load growth will be residential. It is projected that the Spring City electrical system load will increase by 326 KW over the next five years. The area with the largest expected growth over the next five years is a new subdivision in Canal Canyon. Approximately 50 homes are expected to be added to Spring City's distribution system in the next five years.

Many factors may cause variation in the annual kilowatt peak including weather, construction schedules of developers and businesses, annexations, and factors affecting the general economy of the region. The short-term forecasts are most reliable. Longer-term forecasts need to be periodically updated based on current information and forecast trends. Load forecasts should be reviewed, evaluated and compared to actual load levels at the end of each peak loading season.

Spring City Load Forecast (kW)		
Year	**Historical**	**Projected**
2014	1028	
2015	974	
2016	965	
2017	NA	
2018	1108	
2019	948	
2020	1100	
2021		1165
2022		1230
2023		1295
2024		1360
2025		1425

PROPOSED IMPROVEMENTS

Proposed system improvements are summarized in the following table. A brief description of each improvement is given along with a brief listing of the issues that the improvement helps to solve. The estimated costs are in 2020 dollars. System maps showing the location for each proposed improvement are in the appendix. Improvements are numbered the same in the improvements tables and on the maps. A more detailed explanation of load flow results can be found in the Load Flow – Outage Cases section of the report. That section explains what outages were studied and what the results were for the outage cases.

Proposed System Improvements

Proposed Improvement	**Reason/Explanation**	**Estimated Timeframe**	**Estimated Cost**
1. Upgrade the 4.16 kV circuit to 12.47 kV	Improvement: The city is in the process of converting the 4.16 kV circuit to 12.47 kV. The upgrade includes upgrading insulators, cutouts, transformers, and arrestors to 12.47 kV. It is projected that by the year 2025 Spring City will have their entire power system converted to 12.47 kV. The city has budgeted $30,000 per year over the next five years to complete the conversion. This is a total of $150,000 for the project.	2020-2025	$150,000
	Issues the improvement helps solve: The city is upgrading to 12.47 kV to allow for future growth. The system capacity will increase by approximately 3 times by doing the conversion. There are also fewer issues with voltage drop and less system losses when operating at 12.47 kV instead of 4.16 kV. The system currently has two circuits that are operated at two different voltages. Both circuits are radially fed. Loss of a recloser or main line section on a circuit results in the loss of that circuit. Once the conversion is completed, each circuit will be able to be fed from more than one direction. This will allow the two circuits to back each other up.		

Proposed System Improvements			
Proposed Improvement	**Reason/Explanation**	**Estimated Timeframe**	**Estimated Cost**
2. New 12.47 kV Recloser	Improvement: The city is in the process of converting the 4.16 kV circuit to 12.47 kV. As part of the conversion it will be necessary to install a new 12.47 kV recloser to replace the existing 4.17 kV recloser	2020-2025	$30,000
	Issues the improvement helps solve: The city is upgrading to 12.47 kV to allow for future growth. The system capacity will increase by approximately 3 times by doing the conversion. There are also fewer issues with voltage drop and less system losses when operating at 12.47 kV instead of 4.16 kV. The 4.16 kV recloser needs to be replaced with a 12.47 kV recloser as part of the conversion. The system currently has two circuits that are operated at two different voltages. Both circuits are radially fed. Loss of a recloser or main line section on a circuit results in the loss of that circuit. Once the conversion is completed, each circuit will be able to be fed from more than one direction. This will allow the two circuits to back each other up.		
3. New switch at 150 South 300 East	Improvement: Install a new switch at 150 South 300 East. This will be used as a normally open point at between the two 12.47 kV circuits.	2020-2025	$7,500
	Issues the improvement helps solve: The system currently has two circuits that are operated at two different voltages. Both circuits are radially fed. Loss of a recloser or main line section on a circuit results in the loss of that circuit. The 4.16 kV circuit is being upgraded to 12.47 kV. Once this is done there will be two 12.47 kV circuits. The switch will be used as a normally open point between the two circuits. This normally open point will be closed as necessary to feed the circuits from a different direction during an outage or for maintenance.		
		Total Cost	**$187,500**

LOAD FLOW – OUTAGE CASES

System load flow studies were performed for the existing system and for the system in five years. To accomplish this load flows were performed for years 2020 and 2025. The load flow studies were utilized to assess line and transformer loading conditions and system voltage conditions. Tables shown in the System Load History and Forecast section of the report contain projected Spring City system load for years that were analyzed.

N-1 loss of reclosers, main lines, the 4.16 kV circuit transformer, and generation were considered. Load flows were ran with outages taken one at a time. Loads from the equipment that was out of service were transferred to adjacent circuits when possible. In several outage cases, it became apparent that system improvements were necessary. The table below lists the load flow results and discusses required system improvements. Results are based on projected peak load levels. The Comments/Results column of the following table lists ways to restore load during a recloser, main line, 4.16 kV circuit transformer, or generation outage. It also discusses proposed solutions if the outage creates issues.