GUIDELINES FOR GREENING (RENOVATION) OF
EXISTING HOMES

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This Thesis is aimed at evaluating the options of renovation for an existing residential building to make it more energy efficient. The various aspects in the basic structures of residential homes are discussed in order to help the user identify the areas of the house for which renovation is required to improve the energy efficiency of the building. These aspects include doors, roof and wall in addition to various systems of electrical wiring, mechanical systems of ventilation, heating and cooling and plumbing systems for the efficient flow of water throughout the house. The renovation options have been described in detail to provide as many possibilities to the user as possible. The building taken for renovation is a 1953 suburban home which has been awarded the honor of being the first building to be labeled as Zero Energy Home in its vicinity. This has made the home so efficient that its expenditure of energy has become equivalent to its energy generation, therefore, cancelling each other out and creating an estimate of zero energy.
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Chapter #1

1 INTRODUCTION

1.1 What is Green Building?

Green building, or sustainable design, is the practice of increasing the efficiency with which buildings and their sites use energy, water, and materials, and reducing building impacts on human health and the environment over the entire life cycle of the building.

The growth and development of our communities has a large impact on our natural environment. The manufacturing, design, construction, and operation of the buildings in which we live and work are responsible for the consumption of many of our natural resources.

According to Western North Carolina Green building council, in the United States, buildings account for:

- 39% of total energy use
- 68% of total electricity consumption
- 30% of landfill waste
- 38% of carbon dioxide emissions
- 12% of total water consumption

Cities cover under 1% of the world's surface yet are disproportionately in charge of bringing on climate change. Right now, around half of the world's populace lives in cities. Until 2030, 60% of the world's populace development will happen in cities. Cities and urban territories devour approximately 75% of the world's energy and are in charge of up to 75% of greenhouse
gas discharges. Cities straightforwardly or in a roundabout way represent 60% of world's water use. So, a dominant part of the world's energy utilization either happens in cities or as an immediate aftereffect of the way that cities’ capacity is. A concentrate as of late directed demonstrated that more than half of the lessening potential exists in buildings. Making existing and new buildings into Green Buildings is a standout amongst the best levers to meet the difficulties of CO2 lessening in cities.

1.2 Why is it critical to renovate a building to make it a green building?

“Sustainability must be the foundation of all development and conservation planning in the future because human health and wellbeing, and the health of our planet as a whole, is dependent on adopting sustainable practices.” —Tom Hoctor, Ph.D. (Department of Landscape Architecture, University of Florida)

As we know, buildings alone are the greatest and easiest way to address climate change and the least costly way to lower greenhouse gas emissions. House is a system, and Green building does not have to be expensive always nor does it have to look different than any other normal house. It can be designed or changed in any style, or any shape. The main focus of Green building is to provide benefits to the occupants in all its possible ways. A Green building is a building that is designed, constructed, and operated utilizing a whole-system design approach, with the goal of enhancing the overall environmental performance of the building. Our building environment is changing the world significantly. Many of the homes built today consume an inordinate amount of natural resources and energy; building contribute over 40 percent of the total greenhouse gases in the atmosphere, more than either industry or transportation alone.
Green building is a systematic approach that covers every step of design and construction from proper usage of land to materials selection, plumbing, energy efficiency and indoor air quality.

**Energy Effect** – The main purpose of any green building project is to make it consume as little energy as possible and use renewable resources of energy whenever possible. Lower energy use not only saves homeowners money, but also gives societal benefits, such as better air quality and reduced global climate change.

**Conservation of Natural Resources** - There are numerous ways of effective building strategies that conserve natural resources and provide other benefits, such as lower costs. Ways include the use of durable products to reduce waste and specifying recycled-content products that reuse natural resources.

**Indoor Air Quality** - Poor indoor air quality is often caused by mold and mildew that are the result of leaks or poorly designed and maintained heating and cooling systems. Another common source of indoor air pollution is the off-gassing of chemicals found in many building materials. Some are known carcinogens.
Chapter#2: Objective of Thesis

2 Objective

As we know, the world is moving toward the Green Innovation, Sustainable or “Green building” design and construction. As of now, according to the census United States is home for almost 319 million people, and the energy consumption rate is increasing day by day. Around the world, Green building is accelerated as it is a long-term business opportunity and leaves an impact on environment. According to McGraw-Hill Construction almost 51% of Architects, Engineers, Contractors, Owners and Consultants believe more than 60% of their work will be green by the end of 2015, up from 28% of firms in 2012. Being green is not limited to any geographical region or economic state; it is spreading throughout the country. But, there is no change in the old buildings constructed before 2000 or before the hi-tech equipment or energy savers were introduced to the market.

According to STATISTA, a statistic portal, the total number of housing units in the United States in 1990 was approximately 106.28 million.

The objective of the research is to define a framework to reduce the energy consumption and reduce building impacts on human health for the buildings constructed after World War II till 2000. By Deep rehab of the residential buildings and installation of energy star appliances in the building. An average American would be able to save up to $1000 in his or her utility bills and live in a healthy environment.
The study and research focuses on how to opt for the right criteria for a Deep Rehab of the building. It would let you know the key strategies and principles to choose or select the area to reconstruct or to identify the problems and to make changes in the building accordingly.

It would define the elements and baselines for choosing the area of building which needs to be changed by giving the following

A) FRAMEWORK FOR DIAGNOSIS OF THE ELEMENTS

B) APPLICATION OF FRAMEWORK DIAGNOSIS ON CASE STUDY AND RENOVATION

- Site work
- Structure
- Mechanical
- Electrical
- Plumbing
- Finishing

Figure 2-1: Plumbing

Figure 2-2: Electrical
2.1.1 Methodology used

Developing a framework for how to renovate the elements by taking case studies into consideration.

Case study 1: A 1953 suburban home in Garland, Texas, is the nation’s 1st renovated home to be certified to the high performance requirements of the U. S. Department of Energy’s Zero Energy Ready Home Program.

Case study 2: A 1953 house located at 2016 south 5th street, Garland, Texas, was selected for the renovation and to write a go through manual for the Deep Rehab.

This Deep Rehab was done by Steve Brown, owner of Green Extreme Homes and Carl Franklin Homes.

These buildings in Garland are almost 60 years old, and now after renovation, they saved the homeowner more than $1000 a year in utility bills compared to a house built to the current 2009 International Energy Conservation Code.
Chapter # 3: Framework for Diagnosis of the Elements

3 Framework

3.1 SITE WORK

Site work includes the various activities of construction on site which may or may not be aimed at preparing the site for construction. These activities vary in their application; however, most of these are commonly used in one or another type of buildings and cannot be ignored while constructing a building. As for green building, these activities may be modified into using different and more sustainable materials; however, the nature of these activities are expected to remain the same until newer methodologies and advanced techniques of carrying out these activities are developed.

3.1.1 Site assessment

Beside a site assessment by the contractor for the suitability of site for the proposed building, an environmental assessment is also done as per the requirements of the EPA before the building has been initiated. This assessment report contains the various impact analysis of the building project on the surrounding environment. In an ideal situation, the environmental impact of any project should be minimum; however, a conception of zero-energy building has also been introduced which propels the idea of eliminating the aspect of energy losses in the construction of the supposed building.

3.1.2 Excavation, erosion and clearing of site

Excavation

Excavation is regularly utilized as an expansive term which incorporates cut (or excavation) and fill (or dike). Cut is characterized as evacuating material to bring down the rise
of a territory. Fill is characterized as putting material to raise the height of a region. Compaction must happen during a fill operation to build the soil's density material being put. Another normal breakdown in excavation work is mass excavation and trench excavation.

Erosion

As of late, erosion control on construction sites has turned into an issue. Numerous state and neighborhood governments have statutes requiring erosion control for construction projects. Regularly examiners have the power to close down a whole project for erosion control concerns. The impacts of erosion can be abridged as three-fold:

Harm to stream channels: stream channels downstream get to be loaded with residue and flooding can happen.

Harm to water: residue brings down water quality for metropolitan and mechanical use.

Harm to property: residue covers yards, fills trench, stops up tempest sewers, courses and gulfs. Clearly erosion ought to be controlled for both lawful and down to earth reasons.

Erosion is characterized as the separation and transportation of soil particles. Downpour falling on exposed soil separates particles and as the rainwater keeps running off soil erosion happens in extent to the water volume and speed. Erosion can be controlled through both mechanical and vegetable measures. A standout amongst the best mechanical measures includes evaluating, or exasperating, just those regions quickly required for construction. Constraining the territory of uncovered, exposed soil significantly diminishes erosion.

Clearing

The procedure of uprooting and discarding brush and trees is portrayed as clearing. Grubbing is characterized as evacuation and transfer of stumps and roots. Clearing and grubbing is for the most part performed simultaneously with a specific end goal to prepare the site for
topsoil stripping and mass excavation. Demolition at site incorporates evacuation of catch bowls, sewer vents, underground pipe, black-top clearing, concrete clearing, and so on. The strategy for transfer of site decimation materials can have a substantial effect on a venture.

3.1.3 Landscaping

Landscaping refers to any action that changes the obvious components of a territory of area, including: living components, for example, flora or fauna; or what is regularly called cultivating, the craftsmanship and art of developing plants with an objective of making a wonderful environment inside of the landscape; common components, for example, landforms, terrain shape and rise, or waterways; and conceptual components, for example, the climate and lighting conditions. Landscaping requires aptitude in horticulture and imaginative outline.

At the start of site investigation, the landscaping contractual worker makes a letter which is an unpleasant outline and format of what should be possible with the area keeping in mind the end goal to accomplish the sought outcome. Different pencils are required to make illustrations of the photo. Landscaping has turned out to be more innovative than normal, as few undertakings start without bulldozers, lawnmowers, or chainsaws. Different territories have diverse characteristics of plants. Manures are required for this reason in overabundance sums as characteristic landscaping is finished. A few landscapers like to utilize Mix rock with rocks of differing sizes to include enthusiasm for substantial ranges.

3.1.4 Piping and Utilities

Generally, the storm sewer piping streams by gravity, there are no pumps creating pressure involved. The storm water drops into the framework by bays or rooftop depletes then streams downhill. Clearly, the pipe’s evaluation matters. A low spot, or middle, in the pipe makes a trap, while a high spot, or protuberance, makes a dam. So the pipe team needs to keep
the pipe transforms (the most minimal spot in the pipe where the water streams) introduced in a straight line, at the incline required on the drawings.

While the storm sewer piping once in a while shows up on the discriminating way of a task calendar, it's astonishing how frequently the storm sewer establishment gets to be turns into an issue and defers the venture. The typical issues that happen with storm sewer piping are:

- Unforeseen rock excavation
- Existing pipes in the way, found just within the establishment
- Plan slips that just get to be obvious within the establishment

Sanitary sewers require least exfiltration (sewage spilling out of the framework and into the ground) and penetration (groundwater spilling into the framework).

An on-site septic tank takes sanitary waste, permits the solids to settle to the base and break down naturally, and keeps the rubbish on the top from streaming out of the tank. It yields a liquid from the outlet that has significantly diminished suspended solids and can stream into a filtering field (for further natural breakdown with soil contact) without stopping up the channel field framework.
3.2 STRUCTURE

Structures are the major elements of the building. They include foundation, walls and roofing.

3.2.1 Foundation

A foundation is the element of a structure which connects it to the ground and transfers loads from the structure to the ground.

**Why Foundation…?**

Heat is lost through foundation walls, crawl spaces and concrete slabs. Foundations should always be insulated, preferably on the outside to reduce the risk of condensation and make the mass of concrete or block walls part of the conditioned space. An insulated foundation becomes part of the house's thermal envelope, contributing to energy conservation and creating a more comfortable environment.

**How to identify if the foundation has the problems…?**

**Cracks in walls:** This is one of the primary indicators that your foundation has been compromised. A jagged crack running off at a forty-five degree angle is a sure sign that your foundation is shifting and has resulted in actually tearing the sheetrock apart.

**Sticking doors or windows:** Inspect all of your doors and windows. If you have doors or windows that consistently stick for no apparent reason, this can be a sign of your foundation shifting. This happens because the door or window frame twists out of balance as the foundation moves (Martin, 2014).

**Look up:** You might assume that any foundation issues would be most obvious near the ground, but the opposite is actually true. When a foundation has been compromised, the most obvious
signs of damage will be near the top of your house rather than the bottom. Carefully inspect the
top story of your home from the outside using a ladder. Look for cracks that appear above
window frames; this is the most common place for damage to become visible.

**Down Below:** The damage can be visible within the foundation itself as well. Look for
horizontal cracks in the actual foundation. A horizontal crack is a sign of hydrostatic pressure or
too much water pressure building up behind the foundation.

If you have found only hairline cracks that are localized to the visible foundation, mark the
crack and take note of its size so that you can monitor whether or not it gets bigger over time. If
you have found cracks along with some of the other interior signs of a foundation problem, you
might want to change the foundation.

### 3.2.2 Walls

Walls are the structures that define an area, carry a specified load, or give security or
shelter. Walls could be of many kinds:

- Walls forming the basic substructure of the building or as part of the smaller sections of
  the whole
- Walls that retain water, stone or earth
- Solid fences that are permanent

**Condensation**

Condensation is the most widely recognized sort of damp and is brought on by soggy air
condensing on the walls (Trechsel, 1994). For the most part it is a winter issue; during that time
of year walls are much colder than the air inside. Condensation can be exacerbated by poor
ventilation and warming that goes ahead and off, as this permits warm, damp air to condense.
The evacuation of existing fireplaces and fitting water/air proof twofold coating can diminish
ventilation. There are frameworks accessible to enhance ventilation, for example, the Heat positive by Drimaster information ventilation framework.

**Side effects of condensation**

You may notice water droplets on windows or walls, see dull mold showing up and/or notice an obnoxious scent. On the off chance that left untreated, condensation can harm paint and mortar and cause window edges to rot. To clear condensation from windows, you could utilize a device like the Karcher window vac.

**Rising damp**

Rising damp is brought about by groundwater climbing through a wall. Most walls permit some water in, yet it's typically ceased from bringing on harm by a boundary called a damp-confirmation course (Oliver, 1988). This is normally a horizontal plastic or strip of slate in the wall. In the event that this is missing or incapable, your wall may experience the ill effects of rising damp. This sort of damp can likewise happen when the ground's level outside your house is higher than your damp-confirmation course, permitting water to get above it.

**Side effects of rising damp**

In the event that you have rising damp you may notice harmed evading sheets and floorboards, disintegrating or salt recolored mortar and peeling paint and wallpaper. There may likewise be a tide mark along the wall.

**Penetrating damp**

Penetrating damp is brought about by water spilling through walls. This sort of damp may move around inside of a building, however this is through horizontal development instead of by going up walls (similar to the case with rising damp). Penetrating damp is generally created by basic issues in a building, for example, broken guttering or material.
Indications of penetrating damp

Penetrating damp regularly appears through damp patches on walls, roofs or floors, which may obscure when it downpours. Will probably get penetrating damp in the event that you live in a more established building with strong walls, as walls that has cavities give some assurance.

3.2.2.1 Doors

Like most things mechanical, doors can create issues. Luckily, altering an issue door doesn't require years of experience or extraordinary preparing. Indeed, a property holder can deal with most employments with only a couple of basic hand apparatuses and a touch of persistence. Albeit numerous issues are clearly the consequence of customary wear and tear, some appear to show up all alone. For instance, doors can be influenced by the settling of a house a typical event after some time. The reasons can be numerous, yet the no doubt are a disgracefully arranged establishment or drying and contracting confining timber. In a few circumstances, settling can be brought on by floor joists hanging under the heap of a roomful of furniture.

The negative pressure field may envelop the whole building or there may be zones inside of the building that experience negative pressures made by deficient return air ways, or inside door terminations.

An irritating element is the absence of return air exchanges when inside doors are shut. In numerous fabricated and site manufactured homes there is a solitary return situated in the primary body, e.g. lounge room, lounge area, focal passage, of the house. Air coming back from individual rooms can be limited by door conclusion. There is frequently next to no territory accommodated return air from closable rooms; ordinarily this pathway is the undermined at the
doors’ base. At the point when inside doors are shut, the rooms get to be pressurized and the primary body of the house has room for depressurizing.

3.2.2.2 Windows

Condensation Forms between the Panes of Glass

The seals at once or triple-sheet window are breaking down or have as of now fizzled, letting outside air in. Moisture gets caught between the panes and condenses into droplets or turns foggy. The whole window would not need to be replaced while a moisture-fizzled board can be effortlessly replaced with another one.

Condensation Forms in the Glass’ Center, Inside the House

This can be an issue in twofold sheet, gas-filled windows. The gas, regularly argon, breaks out from between the two panes or settles to the window's base, bringing about the glass to bow internal. Now and again, the focuses of the two panes really touch. This typically causes a rainbow impact and leaves scratch blemishes within the unit where the two panes touch; this regularly happens amid the assembling procedure.

When the gas breaks out, the window no more gives great insulation, which is the reason the glass gets frosty in the winter. Argon goes about as a protector while insulating the window is the best way to take care of the issue, and the issue may be secured under a guarantee. The window may not be demolished; it's occasionally difficult to identify when the gas has scattered after some time, however you're paying for what you've lost in insulation.

Double-Hung Window Is Hard to Close and Open

The wood of the window is likely swelling if it has become difficult to close or open the window. Wood windows swell when they're damp or air stickiness is high, making them extreme to work. At the point when the temperature or moistness changes, the window may work easily
once more. On the off chance that that is the situation, you can delicately plane or sand down the wood panes to make them slide effectively year-round.

Wood and vinyl windows have components, for example, springs under strain to make it less demanding to transparent them. The systems fizzle in as meager as five years, making the windows hard to work. It's a typical issue as the parts may should be replaced, and they as a rule cost $15 to $20. Including a silicon or other ointment in the sliding track can make the window transparent all the more effortlessly.

**Casement Windows Won't Shut and Open Easily**

Debris is developed in the window track, or the moving parts should be cleaned and greased up or replaced. Casement windows oblige upkeep to work effectively. Systems wear out, similar to the administrator handle, however it's genuinely simple to change them out. Cleaning moving parts alongside the track and applying an oil can likewise offer assistance. On the off chance that the weather-stripping is sticky, the scarf can be difficult to open. Apply a dry oil to the weather-stripping; don't utilize an oil grease, they draw in soil and tidy. Pop off the plastic spread over the wrench and apply a lithium oil to the riggings to keep them turning easily.

**Water Has Been Leaking Nearby the Window**

The window isn't shutting firmly. To start with, verify you're bolting the window, which can frame a more tightly seal. Amid extreme downpours, water can wind up in the window track. Downpour gets in the track and doesn't deplete out, in addition to hard winds that can blow the water inside once the windows are opened.

On the off chance that a window is closed tight and water is as yet getting inside, and particularly if the hole is going on close to the top, then there's some terrible news. The hole is most likely not because of the window. Rather, it's most likely originating from elsewhere, for
example, the rooftop or siding, and the water is dribbling down the wall and entering at the window.

**Windows Have Become Drafty**

Your window is attempting to let you know: Either the panes or the weather-stripping around the bands should be replaced. The air exchange is through the glass in the window. For a vast window, the region is sufficiently huge for air exchange that it can feel like a draft. This ordinarily needs to do with the window's configuration. Stopping the draft requires another window that is more energy effective. Windows are appraised with a U-esteeem. Dissimilar to the R-estimation of insulation, bring down the U number, the better the window's insulation. Something else, the weather-stripping may be coming free around the scarf. In the event that the stripping is peeling off or has lumps missing, it should be replaced. Halting the drafts ought to bring down your energy charges and enhance the indoor environment of the house.

### 3.2.3 Roof

**Roof Moisture and Leaks**

With any roof, regardless of what sort on the off chance that you have roof releases, then you have an issue. Developed roofs (BUR) may experience spills because of glimmering subtle elements that weren't secured appropriately amid establishment. The issues a proprietor is normally going to have with a BUR system is that 95 percent of holes happen at glimmering points of interest anyplace the layer itself is ended or interfered with. Also, hot bituminous and light connected adjusted bitumen roofs may experience spills when a fitting moisture hindrance is not introduced underneath an adapting top on parapet walls (Madsen, 2004).

It has been established that the ill-advised establishment of glimmering as a wellspring of holes on light connected changed bitumen roofs. Deficient head laps and backwater laps are
another mod piece establishment issue that can permit moisture invasion. Water can get under the layer if the field of roof is introduced with the goal that water streams against the lap. The outcomes of backwater laps are holes and blisters, which can prompt roof failure. With icy connected adjusted bitumen’s, dishonorable capacity of materials can bring about moisture penetration incorporated with the roofing framework, and under-utilization of glue can bring about poor overlay and roof spills.

Breaks can come about when single-handle film roofs are introduced with poor creases. You must have great creases with single-employ, in light of the fact that in the event that you don't, you don't have much. The films themselves will hold water. You must have the creases either stuck or warmth welded appropriately.

**Blow-offs, reduced resistance of wind uplift, tenting, and billowing**

Breaks are by all account not the only issue that can come about because of dishonorably introduced blazing. Hot bituminous roofs where glimmering is ineffectively joined may experience open creases and laps and at last cause blow-offs, diminished cut resistance, and code issues, exhorts C.A.R.E. Poor rock insertion and the utilization of a lacking number of latches in the base sheet amid use of both hot bituminous and light connected mod piece roof frameworks can likewise have comparative results.

Wind inspire resistance can be diminished extraordinarily if creases are not cured enough on icy connected mod piece frameworks. Creases made with cool cements don't have great respectability until the cement has cured. On the off chance that the creases are presented to wind and rain before they are legitimately cured, moisture can penetrate the roof framework or wind inspire can harm the roof layer.
If not held fast appropriately to the substrate, single-handle roofs are at danger for pass over and surging. With single-handle films, we do somewhat more to hold things set up, and on the off chance that it's not done legitimately, then we wind up with tenting of the flashings and in this way people wind up harming the layer.

**Meagre Installation and Unacceptable Workmanship**

A broken establishment significantly improves the probability of issues and diminishes a roof framework’s future. Workmanship tend to be one of the more regular issues or normal purposes behind issues that manifest sooner or later in the roof's life. Bramble framework establishment can be risky if particular arrangements are not taken. Issues with adhesion can come about when the region isn't cleaned, dried, and prepared appropriately preceding establishment. Those are things that are hard to stroll up on a roof and outwardly see, however could prompt future issues, untimely maturing, or untimely failure.

Light connected mod piece framework execution can be bargained if teams don't unwind the sheets preceding establishment. Material planning is vital to a quality establishment. Sheets introduced that have not casual or are introduced when surrounding conditions, for example, temperature are not right can bring about wrinkles, holes, fish mouths, constriction of sheets, or blisters. It’s important to be certain that the temporary worker and team you've procured are instructed in fitting establishment systems particular to the roof they are introducing.

**Lack of Maintenance**

There are numerous reasons not to disregard the roof, including monetary and business coherence reasons. Being astute to issues can keep their heightening. The issue in roofing is an absence of training on all levels. Be that as it may, if the property's proprietor is better instructed, the entire business improves and less issues occur. Particular levels of upkeep are required to
avert voiding the guarantee. You don't need to know a great deal about roofing to perform routine examinations. Things like ponding water, a bit of slipped base blazing, pitch stashes that haven't been filled – those ought to be evident whether you know a great deal about roofing or not. Addressing minor issues before they heighten amplifies roof life and additionally minimizes cerebral pains and cost.

**Ponding Water**

Another normal issue over all roof sorts is the thing that could be called 'coincidental ponding water.' If we move the water off the roof, the roof has a better than average shot of performing the way it ought to. Amid the outline of a dead-level roof, slant ought to be included with decreased insulation or crickets. On the off chance that we don't take proactive measures when we're really planning the roof, then we're building in ponding water.

UV beams intensified by ponding water can have antagonistic consequences for BUR and black-top based mod piece roofs. Amid establishment of hot bituminous frameworks, reprehensible cleaning can deliver voids in the film, square depletes, and result in ponding water and void the guarantee.

Penetrate alerts that before roof repairs are quickly made, the wellspring of the ponding water ought to be researched. HVAC units without condensate channel lines could be the guilty party (Shaffer, 1985). Continuously assess completely before making a repair. Check channels to verify they are free of earth, sediment, and flotsam and jetsam.

**Ruptures and the Addition of Post-Installation Penetrations**

For all proprietors, yet particularly those with single-utilize or splash polyurethane froth (SPF) roof frameworks, harm from pedestrian activity can be dangerous. Punctures are
something on high-movement regions that can be an issue. One of the things we get a kick out of the chance to do is include walkway ways or additional conciliatory layers of film.

The misuse of the completed roof as one of the nine most normal issues tormenting single-employ frameworks. Substantial construction movement can bring about scratches/cuts in the layer and harm to the hidden substrate. Notwithstanding releases, this can bring about untimely issues with the roof film and may void the surety. Limit movement and behavior careless examinations after tradespeople have been on the roof.

All roof frameworks' execution is traded off when new gear and infiltrations are added to a current roof, unless fitting insurances are taken. At the point when infiltrations are included and erased from a metal roof, the outcomes can be grievous. This requires the residents to be left with a tradeoff and a ton of caulking and sealants. Metal roofs move a considerable measure. There is a considerable measure of extension and withdrawal, and in the event that you are left to manage caulking, they are presumably going to have issues in the long run.

Safety

The establishment of hot bituminous and light connected mod piece frameworks requires strict adherence to security methods. Overheating black-top can bring about blazes, and flames in the pot and on the roof. In light connected mod piece applications, fire quenchers ought to be available.

Amid establishment, scents from frosty connected mod piece frameworks can bring about uneasiness and charged disease among building tenants.

Improper Repairs

Utilizing materials that are not planned for application on particular roof sorts can bring about perpetual harm to the roof. A standout amongst the most widely recognized issues we see
with metal roofs is ill-advised repair. Individuals run up with caulking and plastic roof bond and uncalled for materials that are not the slightest bit proposed for that reason. The residents can aggravate a little issue through that ill-advised repair.

**Puncture concurs**

Nonetheless, this issue isn't selective to metal roofs. On a developed or altered roof, that five-gallon pail of plastic bond can take care of a great deal of issues. In any case, on the off chance that I take that five-gallon pail of plastic concrete up on a solitary handle film, I might really harm the layer itself. Take after the producer's directions for fitting utilize and observe repair items with a time span of usability.

**Shrinkage**

Single-handle roof sorts are every one of a kind. In the event that you exit onto an EPDM roof today, one of the first things you're going to search for is confirmation of shrinkage. The two most regular things I see, particularly on ballasted films, are pulling of the flashings (which is because of shrinkage of the field layer) or you could have weakening, surface grazing and breaking of uncured layer, usually utilized at edge and infiltration blazing

**Blistering**

Rankling, ridging, part, and surface erosion are symptomatic, and can in the long run lead to more serious issues. While blisters are not generally worth settling, one of huge size ought to be tended to. The insufficient connection of hot bituminous roof frameworks because of black-top warmed to a despicable temperature can bring about blistering, alongside the slipping of felts, and quickened maturing. Awful interplay uprightness and dry laps can likewise bring about the presence of blisters (Paroli and Booth, 1997).
Voids and occasions can be dangerous in the utilization of light connected adjusted bitumen’s.

Amid the establishment of splash polyurethane froth frameworks, recouping over a wet substrate can bring about serious blistering and delamination.

Guaranteeing a quality establishment, furnishing the roof with predictable support, and the early recognition of issues through routine examinations can amplify roof life. As the roof ages, the probability of issues increments. On the other hand, it is the manner by which these issues are tended to that will focus the destiny and eventual fate of your roof framework.

### 3.3 MEP

The coordination of mechanical, electrical, and pipes (MEP) frameworks is a noteworthy test for complex buildings and modern plants (Tatum and Korman, 2000). The procedure includes finding hardware and directing joining components for every building framework. This multidiscipline exertion is tedious and costly and requires learning in regards to every framework over the task life cycle (Mehdi Sam, 2012). Current practice requires agents from each MEP exchange to cooperate to recognize and resolve impedances. Viable MEP coordination requires reviewing and incorporating learning with respect to plan, construction, operations, and upkeep of each MEP framework (Korman, Fischer and Tatum, 2003).

#### 3.3.1 Mechanical

##### 3.3.1.1 HVAC

HVAC units are normally extremely dependable, however issues emerge. Some of these issues can be do-it-without anyone's help issues (Nunan, 2015). Be that as it may, for the more perplexing issues, it is best to call a prepared expert. At the point when an administration call is
set for a specialist to turn out and check a unit in light of the fact that a customer is not getting any warming or cooling, these are the most widely recognized things that we check:

**Blown Fuses**

Circuits secure the unit's engine or compressor against overheating, and is found in the evaporator loop. At the point when an engine is associated with turning sour, the breaker is one of the first things the professional checks.

**Worn Contactor**

There are three contactors in a unit: one for the compressor, one for the condenser fan engine, and one for the blower engine. The temporary workers draw in when there is a requirement for cooling or warming, making an electrical association. This begins the compressor and engines. Arcing and setting can frame on the contactor making it hard for the electrical current to pass and begin the specific engine.

**Capacitors**

The run capacitor is utilized to assist with the motoring of the unit keep running at a steady speed, appraised in microfarads. Begin capacitors give the compressor a brief increment in beginning torque. On the off chance that either capacitor wears out, it should be traded for your HVAC to work legitimately (Fasolo and Seborg, 1995).

**Gas valve**

The gas valve meters the gas to spill out of your gas line to your unit. They are just utilized amid the warming season. At times the gas valve gets consumed. If so, it should be replaced.
**Channels**

Channels get filthy and stopped up from air particles. When this air channel happens, the channel should be changed. One approach to check if the channel should be changed is to hold it up to the light and check whether you can see light go through it. On the off chance that you can't, the channel should be changed. A grimy channel will lessen the wind stream to the unit creating the unit to solidify.

**Thermostat**

This is the gadget that advises the framework what to do and when to do it. Before calling a HVAC organization, verify the thermostat is on. Ordinarily the thermostat is coincidentally killed or is on the wrong setting.

**Drain lines**

The drain line usually gets to be stopped up with soil or green growth. On the off chance that it is stopped up, the drain dish will top off and make water leak over and make water harm.

**Refrigerant leak**

Refrigerant leaks can happen with vibration of the unit while it is working. Refrigerant leaks in the condenser or evaporator loops can't be repaired (Whitman, Johnson and Tomczyk, 2000). On the off chance that the leak is found in somewhere else the expert can uproot what is left and charge the unit levels back to their right sum.

**Compressor**

The compressor is situated with the condenser curl. On the off chance that the unit is undercharged with refrigerant, the compressor will run hot and will in the long run seize. In the event that the unit is cheated, your fluid refrigerant will return to the compressor and reason fluid slugging. It is vital that the A/C unit has the correct measure of refrigerant.
Condenser Coil

These are situated outside with the compressor. They are presented to the outdoor components, so they regularly get grimy and ought to be cleaned in any event yearly. This should be possible with a water hose when the unit is not working.

Evaporator Coil

On split frameworks the evaporator loop is situated in the loft, however on a bundle unit it is situated outside with rest of the unit. In the event that the curl is situated inside, cleaning may be important if recommended and ought to just be about at regular intervals or thereabouts.

SEER rating

SEER ratings are not a direct measure of efficiency, but the relative difference between ratings gives you good idea of the unit's relative efficiency in using electricity. Hence a 16 SEER should be about 19% more efficient (so roughly comparable lower electricity bill) than a comparably sized 13 SEER unit. 13 SEER is the lowest efficiency currently allowed to be built for general use, 19 SEER is about the highest efficiency made by pretty much all manufacturers, and about 25 SEER is the highest rated though very pricey shelf-item units, though special construction custom units can reach about 30 SEER.

3.3.2 Electrical

3.3.2.1 Lighting Fixtures

Circuit breaker issues

Circuit breakers are intended to trip when a circuit is over-burden. By stopping the electrical supply, the breaker keeps wires from overheating and conceivably beginning a flame. Breakers can likewise trip when they get to be old. Periodic stumbling can show straightforward
over-burdens. Have a go at connecting the apparatus to an alternate circuit. On the off chance that a breaker trips every now and again, you ought to counsel an expert.

Working inside an electrical board requires ability. Indeed, even with the fundamental breaker close off, force is as yet entering the board. Leave this kind of work to an accomplished professional. Never replace a circuit breaker or wire with a higher appraised one in light of the fact that this can bring about overheating and fire (Kezunovic et al., 2005).

For homes dating from the 1950s up to 1990, check your board to see whether it or the breakers are produced by Federal Pacific. The organization's brand of Stab-Lok breakers are not viewed of high-quality and are considered unsafe.

**Electrical shocks**

On the off chance that you feel a gentle stun or shiver when touching a machine, a ground flaw in the apparatus or despicable electrical wiring may be the reason.

In the event that you see a stun subsequent to intersection a covered surface, it might be from static, which is basic in the winter and not reason for concern.

**Hot roof apparatuses**

You ought to sometimes check the zone around your roof light installations for warmth on the grounds that not all apparatuses are all around protected. Furthermore, on the off chance that you surpass the most extreme prescribed wattage for the globule, the apparatus can overheat. An excessive amount of warmth development could represent a flame risk.

Changing to minimal bright light (CFL) or light-radiating diode (LED) globules gives one arrangement, on the grounds that these knobs don't deliver as much warmth as brilliant knobs.
**Gleaming lights**

Glimmering lights may be an indication of an inadequate or free light globule. In the event that replacing the knob doesn't take care of the issue, counsel an authorized circuit tester. The issue may be in the light installation.

Additionally, either the associations with the installation or your home electrical wiring in the circuit breaker box may be free. This sort of electrical issue requires proficient finding to guarantee a complete repair.

**Light switches or electrical outlets are not meeting expectations**

Light switches or repositories that work just discontinuously give away another home electrical issue. The wiring may be free or the gadget may be split inside. On the off chance that an attachment is free in a container, it can represent an issue too. In the event that the fitting incompletely drops out, a clueless individual could unintentionally get a stun while unplugging the rope.

In the event that you think this is the situation, contract an expert circuit tester to review you're wiring to figure out if any free associations exist, and replace any flawed gadgets.

**Burning smell or sparks**

In the event that you see a burning smell originating from any outlets or switches, turn the force off at the electrical board. Contact a qualified circuit repairman for proper repairs. The issue may be a defective gadget, yet it could likewise be a wiring or over-burden issue. A burning scent is a difficult issue on the grounds that it could demonstrate the beginning of an electrical flame. Repositories or associated electrical ropes that are warm to the touch are likewise an indication of an electrical issue. Try not to utilize the container until the circumstance has been repaired.
Infrequent sparks when you first module a machine are not uncommon. Sparks that are expansive or happen much of the time will show an issue with your outlet or the circuit. On the off chance that you hear a popping sound, it may flag that a wire may be free. Finding the free wire in a circuit isn't generally simple. Diagnosing and repairing electrical issues can be precarious, so you'll have to take after security techniques.

3.3.2.2 Wiring

In by far most of cases, a present day circuit breaker is intended to hold a 15-amp breaker for greatest security in many rooms. Be that as it may, numerous property holders replace those unique 15-amp breakers with 20-amp breakers. This can be a lethal slip-up on the grounds that 20-amp breakers are implied for real apparatuses, not ordinary use. Putting on the wrong breaker permits over-burdens to happen without stumbling the breaker, expanding the danger of genuine overheating and conceivably a flame.

Ever since power was initially incorporated into home construction, building codes have required that all home and business wiring must be finished by a qualified and authorized circuit tester. At the point when your house was fabricated, the majority of the electrical outlets must be grounded by. In any case, after some time, those ground wires can come free. Then again if one outlet is ungrounded for repairs, different outlets in the framework get to be ungrounded also. Flawed link grafts, harmed or frayed wires, or cut insulation can be a great flame risk and are regularly an indication of a beginner electrical employment. An issue like this one frequently goes unnoticed. On the off chance that any wiring work was ever done in your home by an unlicensed circuit repairman, you ought to have that work inspected and rectified by a legitimately ensured proficient.
Once well known in the 1960s and 1970s, aluminum wiring can be a noteworthy issue (Hope, 2015). Dissimilar to customary and the sky is the limit from there compelling copper wiring, aluminum wiring grows and contracts as the regular temperature changes, prompting free associations and a noteworthy flame risk (CarsonDunlop.com, 2015). On the off chance that your home has aluminum wiring, consider replacing it. In the event that that occupation is too excessive, at any rate have every one of the associations pigtailed with copper wiring.

The scent of burning plastic or vinyl is unmistakable. Be that as it may, on account of wiring, it might be difficult to find and recognize. Yet, in the event that you smell something electrical burning, see yourself as fortunate, most cautioning indications of electrical flames are imperceptible, vapid, and scentless. Electrical wiring can warmth up and "blaze" for quite a long time before it gets to be superheated and touched off close-by materials.

3.3.3 Plumbing

Low Water Pressure

On the off chance that pressure from a faucet appears to be lower than typical, odds are it's the aftereffect of either, 1) a stopped up aerator, or 2) calcified pipes. On the off chance that the aerator is stopped up, the arrangement is to just unscrew the gadget from the faucet head and physically uproot any aggregated debris. In any case, if years of hard water presentation have left thick calcium stores inside the water pipes, the proprietor may need to re-pipe the whole house.

Moderate Draining Sink

It's very regular for hair, toothpaste, stubbles and different debris to shape gunk balls around pop-up plugs. The arrangement may be as straightforward as uprooting the plug and wiping way the debris. However, in the event that the gunk ball is further down the drain or is in
the sink trap (the U-molded pipe underneath the sink), then a handyman may need to dismantle the whole draining framework to clear the blockage (Ferington, 2010).

**Moderate Draining Tub/Shower**

Once more, this issue is typically brought on by gathered hair. Some of the time, proprietors can evacuate the hairballs themselves utilizing needle-nose forceps or manual winding apparatus. Be that as it may, if the stop up is serious or out of achieve, the administrations of an expert handyman may be required.

**Obstructed Toilet**

Most stopped up toilets can be settled by utilizing a typical plunger. On the other hand, a few obstructs are either so profound or somewhere in the vicinity affected that a mechanical snake is required. Also, in the most compelling cases, pipes are broken and should be replaced by an expert.

**Stuck Garbage Disposal**

On the off chance that a transfer has been stuck by delicate organic material like potato peelings, then a proprietor can regularly free the cutting edges utilizing an Allen torque (a basic L-molded hexagonal instrument) or the key gave by the producer. Be that as it may, if the edges have been bowed by a harder article like a blade or coin, then the whole instrument may must be replaced. The vast majority depend on handymen for this sort of overwhelming obligation work.

**Leaky Faucet**

Infrequently a leaky faucet can be altered by basically replacing a well-used washer (Miller, 1922). Be that as it may, if a whole faucet get together should be replaced, then it might be an ideal opportunity to bring in an expert (de Oliveira and Penna, 1993).
Flawed Water Heaters

Boiling hot water-on-interest is a piece of any cutting edge family. What's more, when the boiling point water falls flat, the outcomes can be felt quickly. Water heaters can come up short as a consequence of broken associations or flawed valves. However, now and again years of wear and consumption require that the whole water heater be replaced.

3.4 Finishes

3.4.1 Floor Finish

Alligatoring

This is a condition in which the finish pulls far from itself, bringing on edges in the finish, like a gator's skin. This condition can happen in both water-based and oil-adjusted finishes. There are numerous conceivable reasons, including poor wetting of the finish, tainting of the finish, application under frosty temperatures, utilization of another coat before the past coat has dried, use of a heavier coat than is prescribed, or the utilization of thinners that cause the finish to dry too rapidly (Miller, 2013). The arrangement is to screen and recoat after the finish has dried adequately.

Application Smudges

This condition is typically connected with water-based finishes. It frequently happens when a despicable spread rate is utilized - an excessive amount of or too little finish is connected - or if the finish is not connected equally. Intemperate air development and unusually high temperatures can likewise be in charge of bringing about the finish to dry too rapidly, with the goal that a wet edge of finish is pulled more than one that has effectively dried. The issue can likewise be brought on by applying a silk or semi-gloss finish that has not been mixed appropriately. The arrangement is to screen and recoat after the finish has dried adequately.
Seep Back

This condition, connected with stain application, happens when abundance stain leaks from the grain or from the spaces between sheets. The clearest cause is unnecessary stain application, however low-thickness stain might likewise be the guilty party. The arrangement is to wipe off the overabundance stain and let it dry thoroughly before applying another coat. On the off chance that finish has as of now been connected over seep back, a complete resand is required.

Discoloration

A few finishes look good in appearance and will yellow significantly facilitate after some time. Wood lying in direct sunlight will blur after some time. These are common changes - the previous condition can't be counteracted, in spite of the pervasive myth that an oil-adjusted finish recoated with water-based finish will quit discoloration. The recent condition can be forestalled by shading the light source. Inconsistent discoloration can likewise happen - particularly in white oak - if a decent sealer is not utilized. This is called tannin pull.

Exaggerated and Early Deterioration

Frequently, the reason is ill-advised support techniques that have either neglected to completely expel coarseness from the floor's surface, or the presentation of water or solid cleaners. Puppy nails, high heels and seat legs likewise add to the issue.

Orange Peel

On the off chance that the finish's surface has a texture that takes after an orange peel, the issue may have been brought on by moving a finish, which then dries too rapidly. At the point
when that happens, the texture is "solidified" into spot before the finish has an opportunity to stream out and level.

**Peeling, Bubbles, Blisters and Fish-Eyes**

Any of these conditions can imply that the floor was not adequately screened between coats of finish, or that cleanser or some other contaminant substance was not evacuated before coating. It’s additionally conceivable that the influenced coat is contrary with the finish or stain already connected, or a debased tool may be mindful. Issues in the top-most finish coat can be screened and re-coated, albeit extreme issues may require complete sanding and refinishing.

**Roughness**

The reason is frequently defilement of the finish amid dry time, in spite of the fact that moisture underneath the floor can likewise bring about the wood grain to rise. On the off chance that a moisture issue is clear, this must be rectified before re-screening and re-coating.

**Stains**

Spilled water and different fluids, including the buildup from contradictory cleaners, can stain finish. Overcast surface finish can be settled by lightly rubbing with an appropriate cleaner and buffing, albeit a few stains require screening and recoating. Solid chemicals ought not to be utilized to uproot stains.

**Sticky Board Condition**

This happens when unnecessary tannic corrosive in the wood keeps the finish from holding fast to the wood. This is most normal with oil altered finishes and with white oak. At the
point when one board or a few sheets scattered throughout the floor won't take stain or finish, the main arrangement is to repair the floor by replacing the sheets.

**Irregular Gloss or Sheen Intensities**

Lacking blending of finish before application, a defiled finish implement and uneven sanding or finish thickness are run of the mill guilty parties. All require rescreening a re-coating. Extraordinary consideration ought to be taken if utilizing diverse sheen levels.

**3.4.2 Wall Finish: Paint**

**Blistering**

Paint bubbles can frame long after the paint has dried. Step to keep away from this issue before it happens. Paint blisters or bubbles happen when the paint film lifts from the fundamental surface. The loss of adhesion between the paint film and surface is normally brought about by warmth, moisture or a mix of both. This condition inevitably prompts peeling. It can be rectified, yet the hidden reason for the issue must be tended to or it will repeat.

**Sticking or Blocking**

Poor imperviousness to paint blocking can bring about painted surfaces staying together, for example, a door adhering to the frame. Paint blocking is an adhesion issue that happens when two newly painted surfaces stick together when squeezed against one another. Whenever isolated, the surfaces show paint exchange or peeling.
**Burnishing**

Burnishing happens if the gloss or sheen of paint film expands when subjected to rubbing or brushing. Rehashed rubbing can bring about paint burnishing. You can avoid it by utilizing the correct paint for high-activity zones that require incessant cleaning (Benjamin Moore, 2015).

**Caulk Failure**

Caulk may lose its starting adhesion and adaptability, which will make it break or pull far from surfaces. Caulk issues are generally because of one of two mistakes: the substrate was not adequately arranged or the wrong paint was chosen.

**Mildew and Mold**

Mildew and mold can show up on the surface of paint or caulk as dark, dim, green or cocoa spots. Mildew is the unmistakable indication of mold. Mildew develop can happen on numerous surfaces, including painted ones.

**Roller Spattering**

Roller scattering happens when a roller throws off little droplets of paint amid application.

**3.4.3 Counter tops**

There are several types of finishes that could be opted for a counter top and each of these are prone to various kinds of defects. These could range from concrete finishes which are perceived as traditional in comparison to glass or steel coverage.
Chapter # 4: APPLICTION OF FRAMEWORK

DIAGNOSIS ON CASE STUDY AND RENOVATION

4 Framework Application

As this residential building will be renovated according to the framework of the elements defined in chapter 3, it would represent the standards of a green building, hence, all factors that were incorporated in it making it more sustainable were considered.

Figure 4-1: After renovation of 1953 suburban home, 2016 south 5th street Garland, Texas

4.1 SITE WORK

As the structure is already present and nothing new is being built, there is no need for the traditional site work. However, clearing of site and landscaping was needed.
4.1.1 Clearing of site

Your land might be heavily wooded, or maybe it just has small trees and brush. Either way, trees, shrubs or other debris must be removed from the areas where your home, septic, well, and driveway will be built. In this case the site had a fish pond (figure 4-3) and a backyard storage shed (figure 4-2). Dirty pond water can be a pain and it may ruin the beautiful backyard of the site. The pond was removed. The storage shed was old and occupying space in the backyard and was ripped apart, and in replacement a new smaller shed was constructed on site (figure 4-4).
4.1.2 Landscaping

If you have a large backyard, you may be able to bury the rubbish on site. But, it is better to utilize it if you are looking towards greening the area. In this case there was an enormous amount of dead leaves, branches, and twigs. So, rather than incinerating and to reduce the carbon footprint, a dual compost system was installed (figure 4-5).

![Figure 4-5: Dual Compost system](image)

According to EPA all composting requires three basic ingredients (epa.gov):

- **Browns** - This includes materials such as dead leaves, branches, and twigs.
- **Greens** - This includes materials such as grass clippings, vegetable waste, fruit scraps, and coffee grounds.
- **Water** - Having the right amount of water, greens, and browns is important for compost development.
We also used an inexpensive way to compost which is wire or a plastic collector (figure 4-6). These types of systems are ready to use and can be removed if not required.

![Image of plastic mesh collector](image)

*Figure 4-6: Plastic mesh Collector*

Finally new lawn and regional plants which used less amount of water were planted in the backyard and front which made the surroundings look beautiful.

### 4.2 STRUCTURE

#### 4.2.1 Foundation

As described in chapter 3, the primary indication of cracks on walls (Figure 4-10) and sticking doors were identified as major signs of problems in foundation. This gave a clear indication that reconstruction for new foundation was needed.
The garage area (Figure 4-8) of the building was converted to a bedroom 10-15 years back, it had no foundation i.e. it was not a slab, but wooden framed box.

The area near it was completely rotted because the outer wall had been framed on the driveway, 5.5" below the floor, concrete was poured on the outside of the wall up to the level of the interior floor, and water has been pouring under this area and into the main house for years. This portion of the house was removed and the concrete flatwork all around the side and rear of house was broken up and removed, and the soil was lowered around the foundation about 6". New foundation was laid and framework for the new bedroom was carried out.
4.2.2 Walls

As mentioned in chapter 3, some of the factors of condensation and dampness were identified. The patch on the ceiling (Figure 4-11) and swollen area of the wall (Figure 4-12) are the sign of presence of moisture in walls. Also in some areas there was worn out insulation (Figure 4-13) found, resulting in renovation of walls and insulation in it.

Figure 4-11: Condensation patch on ceiling

Figure 4-12: Crack and swollen area

Figure 4-13: Worn out insulation
4.2.2.1 Insulation

Wall 1/2" Owens Corning Rigid Insulation R-3 (4'x8') 1/2" Zip Wall with Tape (4'x8') 1/2" LP Smart Siding (4'x8') 3 1/2" L-77 Dense pack Fiberglass (Owens Corning) Roof 8.25".

Blown Foam

Figure 4-15 : Wall Insulation

Figure 4-14 : Blown Foam

4.2.2 Windows:

Windows were found in worn out and drafty conditions, water has been leaking nearby the windows for years, resulting in breakdown of seals and collection of debris. These issues could be solved by proper maintenance and cleaning alongside the track. As this was a concern for moisture and thermal resistance, to help the house at energy efficiency and greening aspect we decided to change it with vinyl frame windows.
Vinyl Frame window

Vinyl frames for window are generally made of polyvinyl chloride (PVC) with bright light (UV) stabilizers to keep daylight from separating the material. Vinyl window frames (Figure 4-16) do not require painting and have great moisture resistance. The empty holes of vinyl frames can be loaded with protection, which makes them thermally better than standard vinyl and wood frames.

Figure 4-16: Vinyl Frame window

The window frames chosen for renovation have the following properties: They are tripled glazed, they have Low-e, they are Argon Filled, they are Double Hung with Tilt Bottom Sash U-Factor 0.23, SHGC 0.22, Visible Trans 0.39, Air Infiltration >0.3.
4.2.3 Roofing:

4.2.3.1 GAF Timberline

Thirty year composition shingles were used in the renovation of this house. It is additionally intriguing to note that the GAF Timberline Cool Series black-top shingles (figure 4-17) meet the Energy Star mark of the Department of Energy (DOE). Amid top air-molding periods, these black-top shingles will lessen the measure of air-molding that is expected to cool the run of the mill home.

![Figure 4-17: black-top shingles](http://esgreenville.com/resources/gaf-shingles/)

The appreciated aftereffect of this is that the home can be more energy effective and have a smaller air-molding framework. Extra advantages of the GAF Timberline Cool Series black-top shingles is that they lessen the warm stun acquainted with the roof, by keeping up a more steady temperature, developing the roofing's life material. These black-top shingles are likewise acknowledged by the Cool Roof Rating Council (CRRC), as a Cool Roof material.
4.3 MEP

4.3.1 Mechanical:

The HVAC systems as stated in chapter 3 are very dependable, but as the ductwork and some issues such as thermostat, drain lines, channels and duct work needed replacement (figure 4-18 and figure 4-19).

Figure 4-19: Compressor

Figure 4-18: Duct work

Figure 4-20: Worn out compressor
4.3.1.1 HVAC 2-ton Unico Mini Duct

HVAC 2-ton Unico Mini Duct High Velocity/Low Volume System with Inverter Driver Compressor was used (Figure 4-21). Utilizing a lower volume of air stream offers better solace as there are no drafts or perceptible air development. Unico small duct frameworks utilize roughly a large portion of the volume (CFM) of air when contrasted with vast ducted frameworks.

![Inverter driver compressor](image)

*Duct effectiveness concentrates on conveyed BTUs which implies that a greater amount of the cooling and warming is conveyed to the living space as opposed to being lost in the storage room region or soffits. A legitimately introduced Unico small duct framework will have less duct leakage than expansive ducted frameworks. Duct framework leakage has been measured as low as 3 percent.*
Size of the duct frameworks is great for modellers and developers. This is reflected in the speedier establishment time and the space required for the frameworks. A 2 ½ ton, 30,000 BTU framework utilizes a 7” round principle duct plenum and a 4 or 5 ton framework utilizes just a 10 inch round fundamental duct plenum. This smaller fundamental duct permits establishment through TGI floor joists if necessary. Small 2” adaptable branch ducts convey the air from the primary plenum to the living space to small 2” round outlets (figure 4-22). These outlets work just as much introduced in the roofs, dividers or floors. The outlets are accessible in different trim choices.

Figure 4-22: Duct convey Branch Outlet

Solace is fundamental and this framework can keep a home inside of 2 degrees, floor to roof; space to room; first floor to second or even third floor. This is proficient by goal of the air versus scattering of the air from huge registers. Extra solace is seen by the mortgage holder with the extra 30% moisture evacuation contrasted with the substantial ducted frameworks. Regularly the mortgage holder can raise their thermostat setting and feel the same solace as one may be more agreeable at a dry 78 degrees than a more sticky 75 degrees. A compressor that is inverter-driven, even though the variable recurrence, tweaks the force limit given, consequently
empowering to advance the performances at partitioned load, expanding productivity.

Additionally, a bigger limit can be achieved at extended load along these lines, guaranteeing that the required temperature will be achieved in a shorter time. A short time later temperature varieties can be effortlessly controlled with minimized energy utilization, on the grounds that once the set is approached, the compressor works at partitioned load, decreasing energy utilization and successfully keeping up the wanted conditions.

4.3.2 Electrical:

Electrical issues are one of the important aspect in reducing the energy and electrical consumption. Working inside an electrical board requires ability. The house had problems with Light switches and electrical outlets they were not meeting expectations.

![Figure 4-24: Main Outlet](image1)

![Figure 4-23: Live wire without insulation](image2)

The electrical supply board in Figure 4-24 shows the lack of maintenance and ignored wiring of the very sensitive issues. Building codes have required that all home and business wiring must be finished by a qualified and authorized circuit tester. Flawed link grafts, harmed or frayed wires, or cut insulation can be a great flame risk and are regularly an indication of a beginner electrical employment. The wiring Figure 4-23 inside the walls were not insulated properly, which would result in short circuit or may be risk of catching fire.
Use of incandescent light bulbs not only increases the electrical bills, but also increases the room temperature. The bulbs installed in the building were all incandescent and were using maximum amount of energy. These bulbs later were replaced with the LED and efficient sensors to cope with this issue. (Figure 4-25, 4-26, 4-27) shows the lighting system in the house.

Figure 4-27: Lighting in Bath Area

Figure 4-26: Lighting in Living Area

Figure 4-25: Lighting in Closet
4.3.3 Plumbing:

Sometimes plumbing can be a big issue in regards to penetration of water in walls floor or ceiling. If your plumbing fixtures are not maintained or not being replaced you would end up spending more money than you thought. The water pipe running from the walls to the bath area were all corroded (figure 4-28).

![Corroded piping](image)

4.3.3.1 PEX system

PEX (cross-connected polyethylene) is a sort of plastic tubing utilized as a part of both plumbing and heating applications. PEX was introduced in Europe about 30 years ago, and its utilization has ended up far reaching in the United States in the course of the last 10 to 15 years. In light of its simplicity of establishment, dependability, and generally minimal effort, PEX is ceaselessly developing in fame.
Points of interest of PEX

Less Leakages: PEX plumbing establishments require less fittings than inflexible piping. This implies there is less probability for breaks to happen at joint associations.

Adaptable: PEX tubing can make 90 degree turns without elbow fittings, and PEX tubing unrolled from spools can be introduced in long keeps running without the requirement for coupling fittings.

Corrosion Impervious: PEX opposes the scale develop normal with copper pipe, and does not pit or consume when presented to acidic water.

Freeze Resilient: PEX is more impervious to freeze-breakage than copper or unbending plastic pipe.

No Water Hammer: Water streams all the more discreetly through PEX tube, and "water sledge" commotion that happens in copper pipe frameworks is for all intents and purposes killed.

Less Expensive: PEX tubing is less costly than copper pipe and establishment time is diminished in light of the fact that less fittings are required.

WaterSense makes it simple to discover and select water efficient products that can help a house owner’s wallet as well as the environment. WaterSense marked products are sponsored by free, third party testing and accreditation, and meet EPA's particulars for water productivity and execution. When you utilize these water saving products in your home or business, you can expect excellent execution, funds on your water bills, and affirmation that you are sparing water for future eras. There are likewise numerous ultra-low-stream fixtures that ration significantly
more water without trading off execution. The plumbing system employed in the renovation of the house is a low-flow WaterSense fixture (Figure 4-29).

4.4 Finishes

4.4.1 Walls and Ceiling: Paint Interior

The paint used for interior was Interior Glidden having No VOC Latex Enamel and Latex Flat. Studies have demonstrated that convergences of unpredictable organic mixes (VOCs) are reliably higher indoors than outdoors, with some VOC focuses up to 10 times higher indoors. A few researchers trust that indoor toxins are 1,000 times more prone to be breathed in when contrasted with outdoor contaminations in light of the fact that we invest around 90% of our energy indoors, our exercises put us close wellsprings of indoor air poisons, and indoor emanations are incompletely caught inside buildings (Fasulo, 2015).
4.4.2 **Flooring:**

**Bamboo Laminate**

Bamboo is a natural surface covering material that has a significant number of the properties of hardwood flooring, despite the fact that it is really created from a kind of grass. The bamboo (Figure 4-30) used for the flooring of this renovation had no VOC as well.

*Figure 4-30: Bamboo Flooring*

Friendly to the Ecology: Bamboo is produced using natural vegetation. The bamboo plant is a profoundly renewable asset that has the capacity develop to development in as meager as three to five years. This is much quicker than hardwood trees which can take upwards of a quarter century more to achieve development.

Simple Maintenance: Bamboo is generally simple to keep up. You simply need to breadth or vacuum it routinely to evacuate small molecule flotsam and jetsam.
Water Resistant: This material is somewhat more impervious to water harm, stains, and twisting than hardwood materials, in spite of the fact that it is still a worry.

Natural Material: The utilization of natural materials is an imperative pattern in the development business at this moment. As individuals are turning out to be all the more environmentally cognizant they are requesting products that mirror these qualities. They are additionally looking for materials and plans that reject the present day treat cutter world and rather concentrate on individual identity and natural development.

Price: This material is priced at about the same level as most hardwood floors. You will frequently discover bamboo ranging from around two dollars to eight dollars for each square foot. You ought to maintain a strategic distance from scratch and dent section materials as they are regularly lower quality castoffs.

Durability: There are certainly sorts of bamboo that can be greatly solid, hard, and tough. Natural, un-carbonized bamboo that was appropriately gathered and produced can be as strong as red oak. Strand woven bamboo can be produced much harder than that.

Style: Bamboo is an in vogue flooring material that can raise the polish of a space quickly.
CHAPTER # 5: 1ST D.O.E. Certified Renovated home

5 CASE STUDY

Figure 5-1: Nations 1St Certified Renovated Green Home

A 1953 suburban home in Garland, Texas, is the nation’s first renovated home to be certified to the high performance requirements of the U.S. Department of Energy’s Zero Energy Ready Home program. This 60-year-old, 3-bedroom rancher saves its homeowner more than $1,000 a year in utility bills compared to a home built to the current 2009 International Energy Conservation Code. Carl Franklin Homes conducted the comprehensive retrofit. Green Extreme Homes worked with vendors, businesses, and local organizations to acquire the grants and volunteers to make the project possible. To meet the high performance requirements of the DOE Zero Energy Ready Home program, the home had to be brought up to Energy Star Certified Homes Version 3.0 levels, meet the U.S. Environmental Protection Agency’s Indoor airPLUS

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criteria, comply with the hot water distribution requirements of the WaterSense program, have insulation meeting the 2012 International Energy Conservation Code, and be made ready for solar electric panels by installing a new meter base on an outer wall, with conduit adjacent to the meter base leading to the roof for future photovoltaic panel installation.

The DOE Zero Energy Ready Home program is a home naming program that tries to convey homes to such abnormal amounts of execution and low levels of energy utilize that a little measure of sun based boards on the roof could make the home a genuine net zero energy home, one that delivers as much energy as it expend in a year. Carl Franklin Homes has been building and retrofitting reasonable and section level homes in the Dallas region since 1993, working for as long as four years with Green Extreme Homes CDC, a Texas-based 501c-3 non-benefit concentrated on efficient moderate lodging.

The group set to work pulling out machines, floor covering, cabinetry, and drywall, gutting the house down to its nails. Actually, one of only a handful of things to be spared inside the house was the hardwood oak flooring, which humorously may have been processed at a wood flooring organization claimed by Brown's family in the 1950s.

Colleagues utilized a sprayer-connected sealant to seal every one of the creases where encircling individuals met or joined outside siding. The 2x4 surrounded wall holes were then loaded with 3.5 inches of shut cell splash froth for an R-estimation of R-20. In the upper room, 5.5 inches (R-39) was showered over the roof deck, totally air fixing and protecting the roof. The insulation contractual workers then went into the crawlspace and splashed an extra 5.5 inches of shut cell shower froth along the floor's underside, protecting it to R-39.
The house is similar to a Styrofoam cooler. On the off chance that you chill it off it stays cool, on the off chance that you get it warm, it stays warm. Texas had a 10-day frosty spell amid construction, with temperatures below solidifying. Albeit Brown had the warmth off.

Shut cell as opposed to foam of open-cell because of the high humidity in focal Texas. The splash froth air seals the structure, keeping moist let some circulation into and molded air in. Protecting froth sealant can be utilized to air seal your home, adding to enhanced solace and energy productivity. Since it is splashed straightforwardly into the crevices, breaks and different surfaces that add to warmth trouble, it both protects and air seals, offering one of the least demanding and best methods for weatherizing existing homes. The foam of two-pounds was so unbending, it adds basic quality to the home (Spraypolyurethane.org, 2015).

The house is warmed and cooled with a ductless mini-split warmth pump that has one outside compressor-condenser unit associated with five inside heads. Ductless, mini-split-framework warmth pumps (mini splits) make great retrofit additional items to houses with "non-ducted" warming frameworks, for example, hydronic (boiling hot water heat), brilliant boards, and space heaters (wood, lamp fuel, propane) (Energy.gov, 2015). They can likewise be a decent decision for room increases where developing or introducing circulation ventilation work is not feasible, and extremely effective new homes that require just a little space molding framework. Make sure to pick an ENERGY STAR® consistent unit and contract an installer acquainted with the item and its establishment.

Like standard air-source warmth pumps, mini splits have two primary segments - an outdoor compressor/condenser and an indoor air-taking care of unit. A course, which houses the force link, refrigerant tubing, suction tubing, and a condensate drain, interfaces the outdoor and indoor units.
5.1.1 Satisfactory green conditions

The primary focal points of mini splits are their little size and adaptability for zoning or warming and cooling individual rooms. Numerous models can have upwards of four indoor air-taking care of units (for four zones or rooms) joined with one outdoor unit. The number relies on upon the amount of warming or cooling is required for the building or every zone (which thusly is influenced by how well the building is protected and air fixed). Each of the zones has its own particular thermostat, so you just need to condition possessed spaces. This will spare energy and cash.

Ductless mini-split frameworks are simpler to introduce than some different sorts of space molding frameworks. For instance, the attachment between the outdoor and indoor units for the most part requires just a 3” gap through a wall for the course. Most makers of this kind of framework can give an assortment of lengths of associating conductors, and, if essential, you can find the outdoor unit as far away as 50 feet from the indoor evaporator. This makes it conceivable to cool rooms on the front side of a house, however find the compressor in a more invaluable or unnoticeable spot on the building's outside.

Mini splits have no conduits, so they stay away from the energy misfortunes connected with the ventilation work of focal constrained air frameworks. Channel misfortunes can represent more than 30% of energy utilization for space molding, particularly if the conduits are in an unconditioned space, for example, an upper room.

In examination to other extra frameworks, mini splits offer more inside configuration adaptability. The indoor air handlers can be suspended from a roof, mounted flush into a drop roof, or held tight a wall. Floor-standing models are additionally accessible. Most indoor units are around seven creeps profound and have smooth, cutting edge looking coats. Numerous
likewise offer a remote control to make it simpler to kill the framework on and when it's situated high on a wall or suspended from a roof.

Split frameworks can keep your home more secure, in light of the fact that there is just a little opening in the wall. Through-the-wall and window-mounted room aeration and cooling systems can give simple access to interlopers.

The exceedingly productive unit has a regular energy proficiency proportion (SEER) of 18.4 and a warming season execution variable (HSPF) of 9.8. The warmth pump additionally utilizes variable refrigerant stream innovation, changing energy to the home's needs, with the capacity to increase to 2.5 tons of limit. The homeowner fundamentally utilized only two of the five indoor air handlers and has a lot of warming and cooling.

A halfway found, profoundly protected electric water heater gives boiling point water to the home with short pipes hurries to the kitchen and lavatory that meet the DOE Ready Home of Zero Energy expenditure high temp water appropriation prerequisites. New machines ranked ENERGY STAR were introduced including a washer, icebox, as well as dishwasher. The greater part of the roof fans and 90% of the light installations are ENERGY STAR-evaluated. The greater part of the installations are outfitted with minimal bright lights.

To give great ventilation, the home has an energy recuperation ventilator (ERV), which has two pipes to the outside – one acquires natural air and one depletes stale air. Energy recuperation ventilation (ERV) is the energy recuperation procedure of trading the energy contained in ordinarily depleted building or space air and utilizing it to treat (precondition) the approaching outdoor ventilation air in private and business HVAC frameworks. Amid the hotter seasons, the framework pre-cools and dehumidifies while humidifying and pre-warming in the
cooler seasons (Dieckmann, 2008). The advantage of utilizing energy recuperation is the capacity to meet the ASHRAE ventilation and energy guidelines, while enhancing indoor air quality and lessening all out HVAC gear limit.

This innovation has not just exhibited a powerful method for diminishing energy cost and warming and cooling burdens, yet has took into account the downsizing of hardware. Also, this framework will take into account the indoor environment to keep up a relative moistness of 40% to half. This extent can be kept up under basically all conditions. The main energy punishment is the force required for the blower to conquer the pressure drop in the framework.

The two air ways cross in a warmth exchanger, which exchanges heat from the hotter air stream to the cooler air stream so the approaching air is slightly warmed then again cooled, contingent upon the season.

5.1.2 EPA Indoor airPLUS Requirements

The developer met the greater part of the EPA Indoor airPLUS necessities including those for low-and no VOC-transmitting paints, finishes, rugs, and cupboards. Indoor airPLUS qualified homes have various preferences.

i. Enhance Indoor Air Quality

Indoor airPLUS is a friend mark to ENERGY STAR. Together, these projects give complete wellbeing securities. Homes fabricated to procure the Indoor airPLUS name incorporate components to diminish contaminants that can prompt poor indoor air quality, including mold, moisture, radon, carbon monoxide, poisonous chemicals and that's just the beginning.
ii. **Minimize Pollutants**

Moisture and pest control, in addition to other things, can ensure your family by wiping out basic allergens from entering the home, for example, mold and pest deposit. Your manufacturer will give a first line of protection against pests like cockroaches and rodents by completely fixing, caulking, or screening where pests enter your home.

iii. **Enhance Comfort**

Your ENERGY STAR and Indoor airPLUS home can give a happier with living environment on the grounds that it incorporates legitimately designed HVAC framework measuring, enhanced channel and gear establishment, enhanced filtration and entire house and spot ventilation to weaken and uproot indoor toxins.

iv. **Secure Against Combustion Pollutants**

The home gives insurance from potential presentation to ignition toxins by the establishment of warming hardware that can't spill burning gasses inside the home and keeping poisons in the carport from going into your home. Likewise, carbon monoxide cautions are in every single resting territory.

v. **Home Maintenance Manual**

In the wake of acquiring a home with EPA Indoor airPLUS capability, it is possible to get a manual clarifying a home's indoor air quality elements and how to work the home to keep minimizing the danger of indoor air quality issues. Furthermore, the home will have a mark as proof that it was assembled to the high indoor air quality particulars on the off chance that the resident has to exchange the home.
vi. Energy Efficiency

Every one of Indoor airPLUS homes should first acquire ENERGY STAR confirmation. ENERGY STAR guaranteed new homes are composed and assembled to models well above most different homes available today, conveying energy effectiveness investment funds of up to 30 percent when contrasted with run of the mill new homes. Another home that has earned the ENERGY STAR mark has experienced a procedure of assessments, testing and check to meet strict necessities set by the U.S. Environmental Protection Agency (EPA), conveying better quality, better solace and better solidness (US EPA, 2015).

5.1.3 Countertops Made of Recycled Paper

Countertops which are made of paper that has been recycled could be an effective way of avoiding the use of unsustainable material while also providing means for saving energy expenditure in the renovation of the house.

It may appear somewhat odd to make kitchen and shower ledge surfaces from reused paper, yet such materials are made to be surprisingly solid and flexible for an assortment of utilizations. They can be utilized as ledges, tabletops, floors, and wall boards. These simple to-watch over ledges oppose water, recolors and scratches, and don't off-gas dangerous chemicals into the home. They can be effectively created with standard woodworking devices. Different edge medicines can be made as well. Variations of Countertops produced using Recycled Paper:

1. Eco-Top is produced using a 50/50 mix of FSC (Forest Stewardship Council) ensured post-shopper reused paper and quickly renewable bamboo fiber. It won't blur or stain after some time and opposes scratches and recolors.
2. Paper-Stone is offered in 11 hues and incorporates two sorts of post-purchaser reused paper ledges. Paper-Stone exceeds expectations in an assortment of imaginative uses from meeting tabletops, signs and plaques, window ledges, slicing sheets and cutlery handles to furniture, restroom segments, cupboards, indoor wall cladding and numerous more creative employments.

3. Richlite makes economical ledges from reused paper. It offers two items that contain post-shopper reused content: r50 which contains half old creased cardboard, and r100 which is made with 100% reused paper. Richlite's special paper surfaces convey a delicate and agreeable feel to a room that is seldom accomplished through frosty, hard stone and plastic strong surfaces. It's produced using environmentally economical assets and is an appealing, sturdy, durable material that supplements an assortment of configuration tastes.

4. ShetkaStone is a characteristic, reused, paper-based surface that is solid, sturdy, simple to look after, and proper for a wide range of engineering and assembling activities. Shetkastone is produced using a wide range of paper: post-purchaser and post-mechanical fiber based materials, for example, magazines, newsprint, cardboard, office paper, and even destroyed cash.

The developer likewise met rules for the Enterprise Foundation Green Communities Criteria, a green building system like LEED however intended for low-pay lodging. Temporary workers worked as one, alongside learners from a Capitol One-financed employment preparing system actualized by Green Extreme Homes, to finish the errand in a little more than four weeks.
Maybe nobody had been more satisfied with the new home than homeowner Bonnie Sanchez, a veteran who had never possessed a home and now has an incredibly high-performing energy-effective home that ought to have service bills of about $40 on the other hand less per month.
CHAPTER # 6: Conclusion

6 CONCLUSION

This Thesis gives a Criteria to identify or point out some of the aspects in the building, some general aspect can be used in all places; but some specific aspect may depend on the condition of the house and the way it was built and also the geographical region can make a difference in affecting the elements. The framework helps to give you an insight on some possible aspects. However, before deciding on any major renovation, it is necessary to plan carefully. This Framework for diagnosing Elements has helped the user to understand that a major part of making a zero energy building is concerned with the energy expenditures of the house. Hence, renovating almost 100 million old buildings can save huge amount of cost and energy.

Using this framework the developer have met the rules for the Enterprise Foundation Green Communities Criteria. Also, achieved a greater part of the EPA Indoor airPLUS necessities including those for low-e and no VOC-transmitting paints, finishes, rugs, and cupboards. Changing the normal ventilation system with a ductless mini-split pump with a compressor while replacing normal material by more sustainable and energy efficient materials.

Net-Zero energy buildings or Green buildings are going through a serious time in present situation the awareness and support are there, but proving the theories and estimates are still necessary. It is very important that green building design meets the promises. If these buildings do not live up to expectations, there would be need of renovating green buildings.

Government plays an important role. If funding is made available, then people would utilize the path of greening their homes. In some states government and some private institutions
are helping people to meet the high performance requirements of the DOE Zero Energy Ready
Home program by giving homeowners certain benefits by financing them or benefits of
certifications of LEED or EPA. However greening does not end with just financing. Need of
educating people, creating an environment to communicate inter-discipline which would give a
grasp to everyone of how the area of green industry actually works.

6.1 Future work

In future this research work can be extended to community levels. Renovating single
house no doubt will save money and energy, but sometimes these buildings create energy more
than its requirements. Same work done at community level would give you a not only savings on
resources but also the energy generation and usage loads can be distributed accordingly. Also
this framework can be broken down to singular elements of the residential building such as
foundation, walls, roofing, and electrical. This framework can be set according to the private
certifications available for different types of building occupations. The most prominent are
USGBC’s LEED, AEE’s (Association of Energy Engineers) GBE (Green Building
Engineer), BPI (Building Performance Institute) Energy Auditor Certification. Specific element
study would give a better design and better operational behavior. These Elements have a very
broader ongoing research and development. In the end, the point comes to that all these
following factors can save a significant amount of energy and natural resources, and would help
in growing the economy and reduce the burden of global warming with the usage of green and
sustainable energies.
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