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Tiny Houses Part 1

Planning and Design Considerations, Legality, and the Engineer's Role

by

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Course Description

This course serves as an introduction to designing tiny houses (houses 400 square feet or less in size). The majority of this multi-part course series focuses on tiny houses mounted on trailers which are often referred to as tiny houses on wheels (THOW). This introduction covers general planning and design considerations regarding trailers, appliances, utility connections, floor plans, and lofts. It also goes over the legal issues concerning construction standards and physical placement of both THOW and tiny houses on foundations. The basis of this course came from my own research, planning, designing, and construction of a THOW I built myself.

Learning Objectives

After completing this course participants should be able to:

1. Understand the differences between tiny houses on wheels, recreational vehicles, and manufactured homes.
2. Recognize the professional services opportunities in the tiny house industry available to engineers.
3. Comprehend the challenges in determining where and how tiny houses on foundations and tiny houses on wheels may be legally placed.
4. Identify the different building/manufacturing standards available for a tiny house on wheels and the pros and cons of each standard.
5. Understand the importance of the addition of Appendix Q to the 2018 International Residential Code.
6. Know the reasoning behind maximum width and maximum height thresholds for mass produced tiny houses on wheels and how and when to exceed these thresholds.

Introduction

The average house size in the United States has grown steadily and significantly since at least the end of World War II. This increase is a result of not only consumer demand, but also government regulation. Over the past few decades a small, but growing segment of the population has transitioned to smaller housing options. This course is the first part of a multi-part course on one of these alternatives – tiny houses. Both tiny houses on foundations (THOF) and tiny houses on wheels (THOW) are topics in this course.



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The exterior of a tiny house on wheels (THOW)



The interior of a THOW is built with most of the same materials as a traditional house to make it look and feel more like a house instead of a trailer or recreational vehicle (RV)



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This course briefly summarizes consulting engineering opportunities both with the tiny house structures themselves and development of sites for tiny houses. The section on how tiny houses can be legally placed and how to research if they are legal in a specific area is likely of interest to both consulting and municipal engineers. An overview of the various construction and manufacturing standards THOW are built to is also included. Of significant note is the 2018 addition of a tiny house appendix to the International Residential Code. Finally, information and planning and design considerations are presented regarding trailers, appliances, utility connections, floor plans, and lofts.

The rest of the course series digs deeper into specific design considerations related to the tiny house structures themselves. Course two focuses on structural design and how to structurally handle the mobile nature of THOW. Course three will focus on the remaining building enclosure components: ventilation, siding, doors, windows, interior finishes, insulation, and air sealing. Course four will discuss mechanical, electrical, and plumbing (MEP) systems with an emphasis on going off-grid or mobile with a tiny house. Look for courses three and four to be released in late 2019 or early 2020.

The basis of these courses came from my own research, planning, designing, and construction of a THOW I have built myself.

Historical Housing Trends in the United States

Housing and related demographic trends have varied greatly during the country's history. This includes housing type (single-family, multi-family owner occupied, non-owner occupied, boarding houses, etc.), housing location (city, suburbs, rural), housing size, and family size, among others.

Boarding houses were commonplace from approximately 1800 until the 1930s. During certain periods some US cities had one-third to one-half of their entire population living in boarding houses. Commonly boarders were not only singles, but also newly married couples. Additionally, workers physically separated from their family's primary domicile were often short-term tenants. This arrangement was not uncommon across the spectrum of income or wealth.

In the 1930s zoning, local codes, and changes in the federal dwelling unit definition led to a drastic decline in the number of boarding houses. The end of World War II and the subsequent



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housing boom in the 1950s shifted the most common housing type for the middle class to apartments and single-family residences.

Average House Size over Time

According to United States Census Bureau and National Association of Home Builders statistics, the average area of a newly constructed single-family house is almost two and one-half times what it was in 1950. During this same time the average household size decreased from 3.37 persons in 1950 to 2.54 persons in 2017. This has resulted in the average floor area per person increasing from 292 square feet in 1950 to 1,036 square feet in 2017 (assuming the average household size in the entire country is a proxy for the average household size of those moving into newly completed housing). See Table 1 for data in years between 1950 and 2017.

Year	Average Floor Area (Square Feet)	Average Floor Area Percent Increase from 1950	Average Household Size (Persons)	Average Floor Area Per Person (Square Feet Per Person)
1950	983	-	3.37	292
1960	1,289	31%	3.33	387
1970	1,500	53%	3.14	478
1980	1,740	77%	2.76	630
1990	2,080	112%	2.63	791
2000	2,266	131%	2.62	865
2010	2,392	143%	2.59	924
2017	2,631	168%	2.54	1,036

Table 1: Average Floor Area of New Single-Family Houses Completed

Municipal Codes, Zoning Codes, and Housing Standards

Consumer demand certainly played a major role in the changing housing trends, but other factors came into play as well. In the 1940s and 1950s many cities added minimum room areas and/or minimum volumes to their municipal codes, zoning codes, housing standards, or building codes. Some cities were very specific and listed minimum areas for living rooms, dining rooms, kitchens, and bedrooms separately. Quite a few of the early city laws based their minimum sizes on the number of occupants. In later years both the room by room requirements and occupant based methods seemed to fall out of common use in favor of an overall minimum single-family house minimum size, typically somewhere between 600 and 1,300 square feet. Today there are still many cities and counties with minimum house size laws on their books.



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Recent Demand for Smaller Housing Stock

As shown by previously mentioned census data, the trend in recent decades is still an overall increase in housing size. However, there seems to be a small, but growing segment of the population desiring smaller housing stock constructed similar to other permanent housing, as opposed to recreation vehicle (RV) or trailer-style construction.

There is no universally accepted definition of a tiny house. For the purpose of this course we will define a tiny house as a dwelling unit 400 square feet or less in area and a dwelling unit as “a single unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.”

Reasons for the demand of smaller housing options vary greatly, but include simpler living; the desire for more affordable housing or elimination of a mortgage; reduced taxes, energy, and maintenance costs; reduced environmental impact; greater flexibility and mobility; people delaying childbirth or deciding not to have children; and the financial and housing downturns in the 2007 and 2008 timeframe.

Cable TV shows like *Tiny House Nation* on FYI and HGTV's *Tiny House Hunters* have increased the popularity and general population's awareness of “tiny living.” These shows have covered both tiny houses on foundations (THOF) and mobile tiny houses on trailer platforms, which are often referred to as tiny houses on wheels (THOW). Both of these types of tiny houses will be discussed in this course.

Differences between THOW and Traditional RVs

Before discussing the role of engineers in tiny house designs it is helpful to discuss the differences between THOW and traditional recreational vehicles (RVs).

RVs can be either self-propelled or pulled by another vehicle. Typically, RVs are designed and built with low weight as one of their top priorities. Most towable RVs weigh less than 10,000 pounds and can be pulled by Class 2 light duty trucks such as a Chevy Silverado, Ford F-150, or Ram 1500. RVs weighting 6,000 pounds or less can be pulled by Class 1 light duty trucks and some SUVs or cars. Photos of the main different types or styles of RVs are shown below.



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Travel Trailer



Fifth Wheel



Left: Class A motorhomes look like buses



Right: Class C motorhomes are built on a truck chassis and have living space that extends over the cab of the truck (Credit: Motorhomes/Wikimedia Commons/CC-BY-SA3.0)

To keep weight down, materials are chosen for their lightweight properties and it's common to use aluminum or fiberglass for exterior finishes; faux wood paneling, vinyl, or vinyl over gypsum panels for interior wall finishes; plastic plumbing fixtures; etc. Walls are often about 2 inches thick.

Present day THOW designers must also be very mindful of weight, but some weigh as much as 20,000 or more pounds. Most THOW are in the 8,000 to 14,000 pound range. Materials used are the biggest difference between THOW and traditional RVs. THOW utilize most of the same siding, roofing, wall framing, wall finishes, plumbing, mechanical, and electrical materials used for traditional house building. Wall thickness is



Example RV wall and ceiling materials



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usually greater than traditional RVs. In short they look a lot more like a traditional house than an RV.



Two THOW exteriors on exhibit at the 2017 Tiny House Expo in Vancouver, Washington

The Engineer's Role

As tiny houses gain popularity, the opportunities for engineer involvement grow. Areas of need include structural design; mechanical, electrical, and plumbing (MEP) design; site development; and planning and zoning assistance.

House Structure and Systems

The building code governs THOF construction. Since meeting most requirements of building codes can be achieved through prescriptive means, THOF in many jurisdictions can be approved, permitted, and constructed without the assistance of any design professionals. Similar to larger, traditional home construction, the use of engineers for a THOF is most likely a voluntary one on the part of the client or builder if they desire custom or complex structures and/or are required by the building official for designs not strictly following prescriptive methods allowed by the code. Some structural components may be oversized if the building code span tables are used (due to the much shorter spans present in tiny houses) so the services of a structural engineer may be desired. Also the conversion of a THOW to a THOF utilizing a custom foundation design may



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become highly sought after in the future, especially if jurisdictions adopt Appendix Q of the 2018 International Residential Code (IRC) in coming years.

Due to the mobile aspect of THOW, the most common design elements builders engage engineers about are structural and electrical considerations. Structurally, the transportation related loadings are of primary concern. Many prospective tiny house owners are also interested in photovoltaic systems and dual alternating current and direct current electrical systems for mobile and off-the-grid applications, so they may also procure the services of an electrical engineer.

Mechanical engineering assistance for heating, ventilation, and air conditioning (HVAC) or drain-waste-vent (DWV) systems are less likely for custom, one-time builds, but are higher for production builders and manufacturers who mass produce a variety of THOW models.

Some production builders and manufacturers like to promote and advertise that they have engineered plans produced, signed, and sealed by licensed professional engineers. In some cases it may even be a requirement depending on the certifications they are trying to achieve.

Site Development

There are also opportunities for civil engineers to develop the roads, water, wastewater, and stormwater infrastructure necessary for individual and groupings of both THOF and THOW. Engineering companies that deal regularly with site development or have dedicated planning divisions may also be asked to assist with planning and zoning compliance related research, permitting, and variances. There will be more discussion of the various types of site development in the section of the course discussing placement of tiny houses.

Design Documents

Drawings

The level of drawing detail required for tiny houses is generally greater than for most other non-custom residential projects. This is due to the limited physical space of the structures, the fact that many inexperienced Do-It-Yourselfers (DIYers) may be using the plans, and that any information normally included in separate specifications needs to be on the plan sheets instead.



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As a minimum the following drawing sheets are recommended:

- Cover Sheet – include design loadings and for a THOW a disclaimer listing the states you are licensed in and legally allowed to practice in
- Floor Plan
- Framing Plans (main floor, loft floors, roof, walls) – show every stud location
- Section Views
- Exterior Elevations
- Exterior Finish Schedule
- Interior Elevations
- Interior Finish Schedule
- Window and Door Schedules
- Plumbing and Mechanical Plan
- Electrical Plan
- Electrical Schedules (load center, lighting fixtures)
- Communication Plan
- Detail Sheets
- Include all necessary IRC fastening tables in your plan set; specify framing hardware for joists, headers, rafters, etc.; call out bolt sizes for trailer to house connections like ledgers and walls; show any specialized structural components you've designed for highly mobile THOW; and show blocking locations on the applicable sheets.

Material List

Designs for use by production builders generally don't require a material takeoff, as the builders are accustomed to producing their own from the drawings. If your agreement with the builder includes an option for selling the plans directly to DIYers it could be your responsibility to produce the material takeoff.

Estimating THOW Weight

To make sure the axle rating is not exceeded every THOW needs a weight estimate completed. Normally this can be accomplished by taking the material takeoff and adding a weight column to it. Low weight mechanical, electrical, plumbing, and miscellaneous components can be lumped together for ease of computation.



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Legality and Placement of Tiny Houses

Legality of Tiny Houses

The legality of both THOF and THOW is highly dependent on where they will be located. For THOW it is even more complicated as they are mobile and their location can change with time.

Let's tackle the issue of legality for a THOF as a tiny house on a permanent foundation is the more straightforward of the two. First, determine the minimum house and/or room sizes, if any, based on county and/or local municipal codes, zoning codes, housing standards, or homeowner association rules. The requirements will likely vary between different zoning districts at the county and municipal levels. Next, check the local building code to determine the minimum dwelling unit square footage required by the code, if any. The typical building code minimums will be discussed in greater detail later in this course. It is common to find a minimum required area of around 1,000 square feet. If the size of the tiny house you are planning is smaller than allowed by the building code the only likely ways to legally build it would be to either apply for and receive a modification or waiver from the authority having jurisdiction or increase the area of the project. If the size of the tiny house you are planning is smaller than allowed by the municipal codes or zoning codes there may be two alternatives – apply for and receive a variance or see if the tiny house would meet the local criteria to qualify as an accessory dwelling unit (ADU). ADUs are separate dwelling units located on the same lot as an existing dwelling unit, typically a single-family home. They are usually used as housing for a family member, a caretaker, or as a rental unit and are colloquially referred to as “granny flats”, “in-law suites”, or similar monikers. Often there are both minimums and maximums for the allowable ADU size. Minimums are typically based on the minimum allowed by the building code; a set square footage, say 300 square feet; or a percentage of the main dwelling unit size, say 15 percent. Maximums are usually based on a percentage of the main dwelling unit size, commonly around 50 percent. If allowed, most zoning codes limit one ADU per lot, but occasionally more than one ADU is permitted.

Portland, Oregon has some of the most lenient ADU laws in the nation. They allow ADUs “by right”, have increased the ADU maximum area to the greater of 75 percent or 800 square feet, now allow 2-story ADUs, reduced setbacks, removed most parking restrictions, eliminated owner occupancy requirements, and have temporarily waived system development charges (impact fees). If you are unfamiliar with zoning terminology or processes you can take a SunCam course entitled *A Practical Introduction to Zoning and Entitlements*.



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Now let's move on to the more complex issue of THOW legality. A THOW can theoretically be converted to a THOF if its trailer is properly affixed to a foundation. However, if it remains solely on its trailer platform the first question is if the state it will be located in considers it an RV, a mobile home, a manufactured home, or something else. Many states include the words "recreational", "camping", "travel use", and other similar terms in their definitions of RVs. Excerpts from WAC 308-100-210 for Washington State define recreational vehicles as "vehicles used exclusively for noncommercial purposes which are" "primarily designed for recreational, camping, or travel use." Similarly, an excerpt from Florida Statutes 320.01 defines recreational vehicle-type units. It states, "A recreational vehicle-type unit primarily designed as temporary living quarters for recreational, camping, or travel use, which either has its own motive power or is mounted on or drawn by another vehicle." You may have noticed the Florida statute also includes the term "temporary living quarters" in its RV definition. As a result, a snow bird may be able to have their THOW classified as an RV, while a permanent resident is more likely to fall into the mobile home category, or, in rare instances, in the manufactured home category.

States' definitions typically say manufactured homes are houses that meet the *Manufactured Home Construction and Safety Standards*. To meet this standard the builder or manufacturer must have met stringent inspection and certification requirements which are things most tiny house builders have not done. After checking state law, the same exercise needs to be accomplished by reviewing county codes and, if the project is in an incorporated area, municipal codes. After performing initial due diligence regarding classification based on state and local laws it may also be useful to discuss your intentions with the motor vehicle department and local land planners.

Prior to moving a THOW to another state or traveling out of state with it, the owner would need to determine how the new state classifies it and if oversized load permits are necessary for movement. An infrequently moved THOW may not require a permanent license plate in some states. For example, in Washington State you can pay a small fee for a temporary license permit whenever you move it. Some municipalities have placed licensing requirements in their ordinances allowing THOW so in those instances licensing would be required.

There is a 3-part documentary entitled *Living Tiny Legally* that provides a good overview of many of the issues and some of the solutions people have found related to THOW legality issues. The first two parts have been released and are available for viewing on YouTube. Part 3 is planned for release in 2019.



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Tiny House Developments

Besides interest in individual tiny houses, there is substantial interest in groupings of tiny houses. Tiny house hotel developments, clusters of overnight and short-term THOW rentals, have popped up all around the country. Washington, Oregon, California, Arizona, Colorado, Wyoming, Texas, Georgia, Tennessee, South Carolina, North Carolina, Florida, Virginia, Maryland, Pennsylvania, New York, Massachusetts, and New Hampshire all have existing sites.

THOW developments are also beginning to copy the RV park and RV resort model where lots are rented by the month or sold like real estate. Non-rental lots typically include a monthly fee similar to a homeowners association (HOA) fee to cover grounds and road maintenance, utilities, and upkeep of community pools, playgrounds, clubhouses, and the like. Some of these parks and resorts are only open seasonally, but many of them still allow for the yearlong storage of tiny houses if owners wish.

Potentially Applicable Land Use Codes

A THOF development must be designed to comply with the county or municipal land use code. Likely the land use code will contain one or more chapters concerning cottage housing, pocket neighborhoods, micro-housing, mobile home parks, or other similar terms. A THOW development will also need to be designed to comply with the county or municipal land use code. Likely, the land use code will contain one or more chapters concerning recreational vehicles, campground and recreation facilities, mobile home parks, or other similar terms. In the case of all types of tiny house developments it is essential to perform your initial research and then present your plan to the local land planner and building official for their feedback prior to moving beyond the conceptual site development stage.

Below are a few examples of counties and municipalities throughout the country that have recently changed their minimum square footage requirements or approved large scale tiny house developments through existing or newly revised land use codes. The driving factor for many of the changes was to help increase the affordable housing stock in their area.

- The California counties of Alameda, Contra Costa, Lake, Mendocino, Napa, Sacramento, and Sonoma: These counties allow THOW in backyards as caregiver dwellings.
- Fresno, CA: THOF and THOW are allowed as backyard cottages by municipal code Section 15-2754. Among other restrictions, both minimum lot sizes and maximum building square footage apply.



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- Salida, CO: In 2016 the city council approved a 200 unit tiny house rental development. Additionally the development includes a community building, exercise facility, management office, restaurant, storage units, and parks.
- Walsenburg, CO: Tiny houses between 120 and 600 square feet are allowed.
- Rockledge, FL: Both THOF and THOW between 170 and 1,100 square feet are allowed in pocket neighborhoods located in Planned Unit Development and Redevelopment Mixed Use zoning districts.
- Detroit, MI: At least one zoning district allows 250 to 400 square feet tiny houses. At least one development has been approved and the first house was completed in 2016.
- Lake Dallas, TX: In 2017 the city council approved a THOW village. The lots are rented on 12 month leases for \$500 to \$550 per month, but each renter must provide their own 100 to 400 square feet sized THOW.
- Spur, TX: In 2016 the city council passed a resolution declaring itself as the first tiny house friendly town. Size doesn't matter, but it must be set on a permanent foundation and be connected to city utilities.
- Seattle, WA: Pocket neighborhoods of THOF have been developed using the Cottage Housing Development section of their land use code. Developments must contain four to twelve cottages and there are various cottage square footage limitations.

Construction and Manufacturing Standards

Due to the great variation and uncertainty in how states, counties, and municipalities classify THOW and the limitations these differences place on THOW moving around the country, some THOW builders have decided to go through the process to become a Recreation Vehicle Industry Association (RVIA) certified manufacturer. This certification means states will consider THOW built by these manufacturers as RVs. This helps buyers obtain more traditional financing, and simplifies the insurance and DMV registration processes. However, at the same time, it limits legal full-time occupancy in the majority of locations since recreations vehicles are often only allowed for travel and temporary use. Some builders have decided not to pursue the RVIA certification for this or other reasons including the cost of certification and because they produce high end, customized projects as opposed to mass produced models. Many of the builders that don't have RVIA certification attempt to follow the local building code as much as possible. A third possible standard is the manufactured home standard. A short discussion on that standard is provided in the [Manufactured Home Standards](#) section of this course.



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RVIA Certification

The RVIA has adopted four standards for the construction of RVs and Park Model RVs. Park Models in the United States are generally required to be 400 square feet or less and not exceed 14 feet in width. Park Models tend to look more like manufactured homes or tiny houses than RVs.



A Park Model RV located in an RV resort (notice the travel trailer style RV in the left background)

Most states classify Park Models as RVs, but their greater width compared to most other RVs means they are not moved very often. Since they are not as mobile, and therefore weight is not as big of a concern, they are often constructed using more traditional light fixtures, plumbing fixtures, etc.

The RVIA adopted standards are:

- 2015 ANSI A119.5 *Park Model RV Standard* which covers plumbing, fuel burning, electrical, fire & life safety, and construction
- 2018 NFPA 1192 *Standard for RVs* which covers plumbing, fuel burning, electrical, and fire & life safety
- 2017 NFPA 70 *National Electric Code* which covers high voltage electrical systems and is also used in “traditional” construction



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- 2018 ANSI/RVIA *Low Voltage Standard* which covers low voltage electrical systems



Certification decal from a fifth wheel RV showing NFPA 1192 compliance

Building Codes

The regulation of building construction in the United States began in the late 19th century, predominately in more populated cities, in response to devastating, quickly spreading urban fires. Over time the regulations evolved from being fire-centric to also include structural safety, safe ingress/egress, proper water and wastewater sanitation, electrical safety, indoor air quality, and other related health, safety, and welfare of occupant topics.

Near the end of the 20th century there were three major building code writing organizations, and as a result three major model building codes. These three codes were adopted for the most part based on geography; the Uniform Building Code by the western states, the Standard Building Code by the southern states, and the BOCA National Building Code by the Midwest and eastern states.



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The three major code writing entities merged in 1990s to form the International Code Council (ICC). The ICC publishes a set of 15 codes called the I-Codes and revises them every three years. The most well-known of these codes are the International Building Code (IBC), the International Mechanical Code (IMC), the International Plumbing Code (IPC), and the International Residential Code (IRC). The IRC “comprises all building, plumbing, mechanical, fuel gas and electrical requirements for one- and two-family dwellings and townhouses up to three stories.” Since tiny houses and other small dwelling units meet these criteria, the IRC will be the building code referenced in this course. Specifically, the 2018 IRC edition was chosen for reasons expounded on later. The 2018 IRC can be viewed online for free on the ICC website at <https://codes.iccsafe.org/content/IRC2018>.

Each state chooses whether to have or not have state-wide building codes. For example, as of 2018, Kansas had no state-wide building codes and Delaware allowed for adoption at the county or municipal level with the exception of a state-wide plumbing code, mechanical code, and energy conservation code. If states choose to have codes they can adopt model codes or write their own. As of 2018, most states have chosen to adopt some of the ICC codes. In some instances states publish and title their own codes. Florida is one such example. The Florida Building Code took I-Code text and modified it. There were enough modifications the state deemed it better to produce a unique code instead of publishing a long list of additions, deletions, and changes to the model code. Additionally, jurisdictions at any level (county, city, town, etc.) may further adopt and/or amend model codes unless prohibited by law (state law for counties, county law for municipalities).

Most states that adopt model codes don't automatically adopt the latest edition of the model codes and as a result it is common to be one or two code cycles behind the latest published edition.

2012 IRC Minimum Size Requirements

IRC 304.1 states, “Every dwelling unit shall have at least one habitable room that shall have not less than 120 square feet (11 m²) of gross floor area.” *Habitable space* is defined by the IRC as “A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered habitable spaces.”

IRC 304.2 reads, “Other habitable rooms shall have a floor area of not less than 70 square feet (6.5 m²).”



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IRC 306.1 says, "Every dwelling unit shall be provided with a water closet, lavatory, and a bathtub or shower."

IRC Section 307 covers toilet, bath and shower spaces, and provides a figure with multiple drawings showing minimum clearance and spacing requirements, including a minimum shower size of 900 square inches. Depending on how the bathroom is laid out and the areas chosen for a water closet (toilet) and shower, the minimum size for a code compliant bathroom is somewhere slightly under 20 square feet. The lavatory (sink) is not required to be in the bathroom and can be placed in the kitchen or elsewhere.

Since the IRC doesn't prohibit living, sleeping, and cooking from occurring in the same room (think studio apartments) the minimum dwelling unit size could be interpreted as the sum of one habitable room and one minimally sized bathroom, which is a total of approximately 140 square feet. Please note Sections 304 and 305 also provide ceiling height requirements for habitable spaces and bathrooms.

2015 IRC Minimum Size Requirements

The 2015 IRC removed the requirement for every dwelling unit to have at least one habitable room 120 square feet or larger; however the 70 square feet minimum for habitable rooms remained.

IRC 304.1 states, "Habitable rooms shall have a floor area of not less than 70 square feet (6.5 m²) Exception: Kitchens." Again *habitable space* is defined by the IRC as "A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered habitable spaces."

The language of IRC 306.1 and IRC Section 307 regarding bathrooms remained the same as in 2012.

Again since the IRC doesn't prohibit living, sleeping, and cooking from occurring in the same room the minimum dwelling unit size could be interpreted as the sum of one habitable room and one minimally sized bathroom. This is a total area of approximately 90 square feet and a reduction of about 50 square feet compared to the 2012 IRC.



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2018 IRC Minimum Size Requirements

There were no changes to the sections pertaining to minimum room areas between 2015 and 2018.

2018 IRC Appendix Q

The IRC in 2018 added Appendix Q, entitled *Tiny Houses*. Just like the main text body of the IRC, this appendix would need to be adopted by the authority having jurisdiction for it to come into effect. A jurisdiction may choose to adapt the IRC with no appendices, all appendices, or some appendices. This course uses the 2018 IRC as its code reference because of this new appendix.

If adopted, Appendix Q “relaxes various requirements in the body of the code as they apply to houses that are 400 square feet in area or less.” The entire text of Appendix Q can be viewed at <https://codes.iccsafe.org/content/IRC2018/appendix-q-tiny-houses>, but a brief summary of the key points is provided here.

First, four new definitions are added to the IRC by the appendix. The two most important are: a *loft* defined as “A floor level located more than 30 inches (762 mm) above the main floor, open to the main floor on one or more sides with a ceiling height of less than 6 feet 8 inches (2032 mm) and used as a living or sleeping space.” and a *tiny house* defined as “A dwelling that is 400 square feet (37 m²) or less in floor area excluding lofts.” The major takeaways I see from these definitions are:

- An attempt to bring a more universal definition of what size constitutes a tiny house in the United States. I think the 400 square feet size was chosen to match the Park Model maximum area.
- Lofts don't count as part of the dwelling's area.
- A loft may be used as a living or sleeping space, which was not something the IRC main text body allows since normally living and sleeping spaces are deemed habitable spaces and must have ceiling heights not less than 7 feet.

Appendix Q goes on to:

- Reduce habitable space and hallways ceiling heights to not less than 6 feet 8 inches.
- Reduce bathroom and kitchen ceiling heights to not less than 6 feet 4 inches.



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- Give minimum loft floor area (35 square feet), minimum loft horizontal floor dimensions (5 feet), and criteria for how ceiling heights effect calculation of living and sleeping loft areas.
- Allow access and primary egress from lofts by four methods: stairways, ladders, alternating tread devices, and ships ladders. Relevant dimension requirements are provided as well.
- Provide requirements for, and mandates the use of, loft guards (think railings or balusters) on the open side(s) of lofts.
- Allow skylights and roof windows meeting specific dimensional requirements to meet the emergency escape and rescue opening requirements of IRC Section R310 in lofts used as sleeping rooms.

Technically Appendix Q applies to THOF not THOW, but as mentioned previously, many THOW builders try to follow the IRC as closely as possible. The authors of Appendix Q, which were a group of architects, builders, and tiny house advocates who submitted the appendix text to the code committee, believe this appendix is a gateway to transitioning a THOW to a code approved THOF with a certificate of occupancy (CO) for full-time occupancy. This would be achieved by first designing a THOW to meet the IRC and Appendix Q provisions. Then, whenever ready to convert to a THOF, obtain an IRC Chapter 4 compliant foundation design and connection details between the foundation and trailer from a professional engineer. The owner would then submit the design to the building department for issuance of a building permit and eventually a CO following construction. This is similar to the widespread process for placing a manufactured home on a permanent foundation and obtaining a CO in accordance with IRC Appendix E or local ordinance. The biggest difference is that manufactured homes are built to a federal standard and their manufacturing is subject to inspection – THOW are not. Depending on what inspections are required by the local building department, some selective demolition and testing might be required to prove the previously constructed THOW met all code provisions.

While certainly not a guaranteed workaround, taking comprehensive video and photographs during construction may be sufficient evidence for a building official not to require selective demolition. At the very least this documentation would be helpful if the THOW is ever sold as it could provide information on the quality of construction.



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Manufactured Home Standards

Manufactured homes in the US are constructed to the *Manufactured Home Construction and Safety Standards*, often referred to as the HUD Code, not a model building code like the IRC. However, much of the text was copied from building codes or reference standards like the National Electric Code. So basically it is its own unique building code. The HUD Code can be found in Title 24, Subtitle B, Chapter XX, Part 3280 of the Code of Federal Regulations.

The first portion of the HUD Code's definition of a *manufactured home* is "a structure, transportable in one or more sections, which in the traveling mode is 8 body feet or more in width or 40 body feet or more in length or which when erected onsite is 320 or more square feet, and which is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air-conditioning, and electrical systems contained the structure. This term includes all structures that meet the above requirements except the size requirements and with respect to which the manufacturer voluntarily files a certification pursuant to §3282.13 of this chapter and complies with the construction and safety standards set forth in this part 3280. The term does not include any self-propelled recreational vehicle." This definition allows a THOW less than 320 square feet to be classified as a manufactured home, but only if construction follows the HUD Code standards and certification is obtained. Any manufactured home built on or after June 15, 1976 is required to have both a data plate and certification label.

A THOW with a sleeping or living loft cannot meet the HUD Code since the standard requires all habitable rooms to have a minimum ceiling height of 7 feet. Also, a manufactured home must have at least one living area not less than 150 square feet and sleeping rooms must have a minimum area of 50 square feet. Both proof load testing for a 12 hour period and ultimate load testing until failure (by reaching deflection limits, rupture, fracture, or excessive yielding) on each structural assembly is required by the HUD Code which means following the standards is only economically feasible for mass production. Because of the manufactured home ceiling height mandate, room size minimums, structural testing requirements, and builder certification most THOW builders choose to build as closely to the IRC as they can or in some instances get their RVIA certification and build to that standard.

Inspection Letters of Certification

Another potential path forward for concerns related to inspections and THOW is the inspection letter of certification route. The Construction Careers Academy in San Antonio, Texas is a



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magnet high school focused on architecture, engineering, construction management, and the trades. Teams of students design and construct THOW. This portion of their education is self-funding as each team sells their THOW after completion. The city of San Antonio reviews the permit submittals and inspects each THOW at each normal inspection stage. After completion the city issues a letter of certification listing the codes used for design and inspection, in this case the various codes San Antonio has adopted. This letter of certification can then be presented to their local building department to hopefully reduce concerns about the local building department not performing their own inspections. This idea is very similar to the manufactured home model.

Some locations in the United States also allow state licensed engineers and state licensed architects to provide certain construction inspections in lieu of the local building inspectors. Usually a signed and sealed letter stating that the engineer, architect, or their designated representative inspected the construction for "general conformance with the construction documents" or similar language is required. San Antonio is one city that allows this practice.

Planning and Design Considerations

Architects ask their clients many questions prior to beginning the design process for traditional homes. Common questions cover topics such as desired size; budget; house style preference (Colonial, Craftsman, Federal, Modern/Contemporary, Ranch, Tudor, Victorian, etc.); number of occupants; types of spaces needed; spaces they spend the most time in; pets or no pets living inside; and other questions about their lifestyle, needs, wants, and wishes.

The same process should be followed prior to beginning a tiny house design; however, there are some additional common questions that are critical not only to an architect or designer, but to engineers as well. These additional questions include, but are not limited to:

- What are the heights of the occupants?
- Are lofts wanted or is single-story living required?
- Will occupancy be full-time, seasonal, for personal guests, or for rental guests?
- For a THOW what will the frequency of movement be? Once to a permanent site? A few times a year? Multiple times per month?
- If frequent movement is anticipated are water and wastewater tanks desired?
- If frequent movement is anticipated will all locations have grid power available? If not what equipment (laptop, cell phone, printer, etc.) must be powered by off-grid electrical generation as opposed to non-electrical energy sources like propane?



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- If frequent movement is anticipated what states and geographic locations will the majority of time be spent? The specific states are important because of varying departments of transportation requirements. Geographic location is important for structural and mechanical design based on climate.
- For THOF and infrequently moved THOW what utilities will be available? Even if utilities are available is off-the-grid living capability desired?
- What are the primary reasons for transitioning to a tiny house? Affordability? Simplicity/Minimalism? Self-sufficiency? Environmental/Sustainability considerations? Flexibility and/or mobility?
- Will the tiny house be built by a contractor or the homeowner?
- Are there any specific key features the occupants insist on? (In our case, my wife wanted a bath tub, lots of windows, and the bathroom as far from the kitchen as possible.)

All material and product costs or estimated costs in this course are given in 2018 dollars. Some costs vary greatly from region to region. Also, mention of a specific product is not necessarily a recommendation of that product. While I have specified and personally used many of the products listed, others I have not. The purpose of listing products I have not used is to illustrate that products exist for a specific application. Please perform your own due diligence.

Trailers for THOW

Maximum Width, Height, and Length without Permits

Almost all mass produced THOW are no wider than 8 feet 6 inches and no taller than 13 feet 6 inches. This is because the most restrictive state laws and regulations define oversized loads as wider and taller than these dimensions. These limitations make sense for a builder that sells in all 50 states and has no idea if the THOW will be moved frequently or not. Using these dimensions means owners don't have to worry about getting oversized load permits.

Custom THOW that will stay in a single state or only occasionally travel in a few different states might be able to be designed larger than the most restrictive state dimensions and still not require an oversized load permit for movement. For example, in both Oregon and Washington State a traveling load can be 8 feet 6 inches wide and 14 feet tall and not require an oversized load permit. Some states allow up to 14 feet 6 inches in height before requiring a permit. Single oversized trip permits are inexpensive, typically \$15 to \$75 dollars, depending on the state. Some states adjacent to each other recognize each other's permits and as a result only one permit may be required for interstate transport. Pilot and escort vehicles often are not required until the



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width approaches between 12 and 14 feet. Due to the low cost of permits, if a THOW will not frequently move, it may be worthwhile to design and construct it to larger dimensions that necessitate a permit. It is recommended to stay below the pilot and escort vehicle threshold width and 14 feet in height due to the high number of highway overpasses that cannot accommodate loads approaching 14 feet 6 inches.

THOW lengths are not problematic since most states allow lengths in excess of 50 feet without a permit.

Axle ratings on THOW trailers will govern the total weight allowable for the tiny house. State department of transportation (DOT) limits on per axle weight exceed typical trailer axle ratings by significant margins. DOT gross weight maximums are usually around 80,000 pounds which is much greater than any THOW.

Trailer Characteristics

Early THOW were constructed on modified flatbed, utility, and occasionally gooseneck trailers. Sidewalls, decks, and ramps would be removed and holes drilled through the metal frame to facilitate tiny house floor and/or wall connection to the trailer using bolts, washers, and nuts. Since trailer electrical wiring for lights and signals is often run inside of structural steel members, the chance of damaging wiring while drilling holes was not insignificant.

As demand rose, local and regional trailer manufacturers as well as some tiny house builders began fabricating and selling trailers designed specifically for tiny houses.



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Tiny house specific trailer with galvanized sheet metal bottom pan to protect the floor assembly from water and insects

Common characteristics of these specialty trailers include:

- Larger structural members around the perimeter of the trailer for exterior load bearing walls to sit on and smaller structural members in the interior of the trailer where no walls or non-load bearing walls are present. Most flatbed trailers have larger structural members in the interior trailer area to support uniform loading, such as a car being driven up on them; however, this is an unnecessary weight penalty for a THOW.
- Slightly lower trailer deck heights to maximize available headroom.
- The interior structural members are smaller in both cross-section and height to allow for floor framing (some trailers have enough room for 2x6 floor joists) and insulation below the deck instead of above the deck. This also increases available headroom and reduces thermal bridging due to smaller areas of trailer structural steel extending through the entire floor assembly.
- Differing axle positioning compared to cargo trailers to provide better balance for the typical house loading distribution.
- Trailer widths at or just narrower than the maximum allowed without an oversized load permit. The slightly narrower widths are intended to leave room for wall sheathing, siding, and trim and still remain narrower than 8 feet 6 inches.
- Pre-drilled holes in the trailer structure for both floor system connection and wall system connection.



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- Galvanized, sheet metal pan installed on the bottom side of the trailer deck to protect insulation and floor framing from road water splash in mobile applications and from vegetation, insects, and the elements in stationary applications. Depending on the manufacturer this may be a standard feature or an upgrade.
- Scissor jacks welded to each trailer corner to assist with quicker leveling. Depending on the manufacturer this may be a standard feature or an upgrade.
- Welded fenders flashing to eliminate the need for custom flashing above the fenders and wheel wells. Depending on the manufacturer this may be a standard feature or an upgrade.



You can see large structural members on the perimeter, pre-drilled holes for connecting walls to the trailer frame, small interior structural members, and room for floor framing below trailer deck. The steel angles welded to the steel tube(s) forming the perimeter frame are great for placing the exterior walls on, but there is one negative tradeoff – plumbing drains must go through the floor adjacent to the exterior walls, not in the walls as they normally would.



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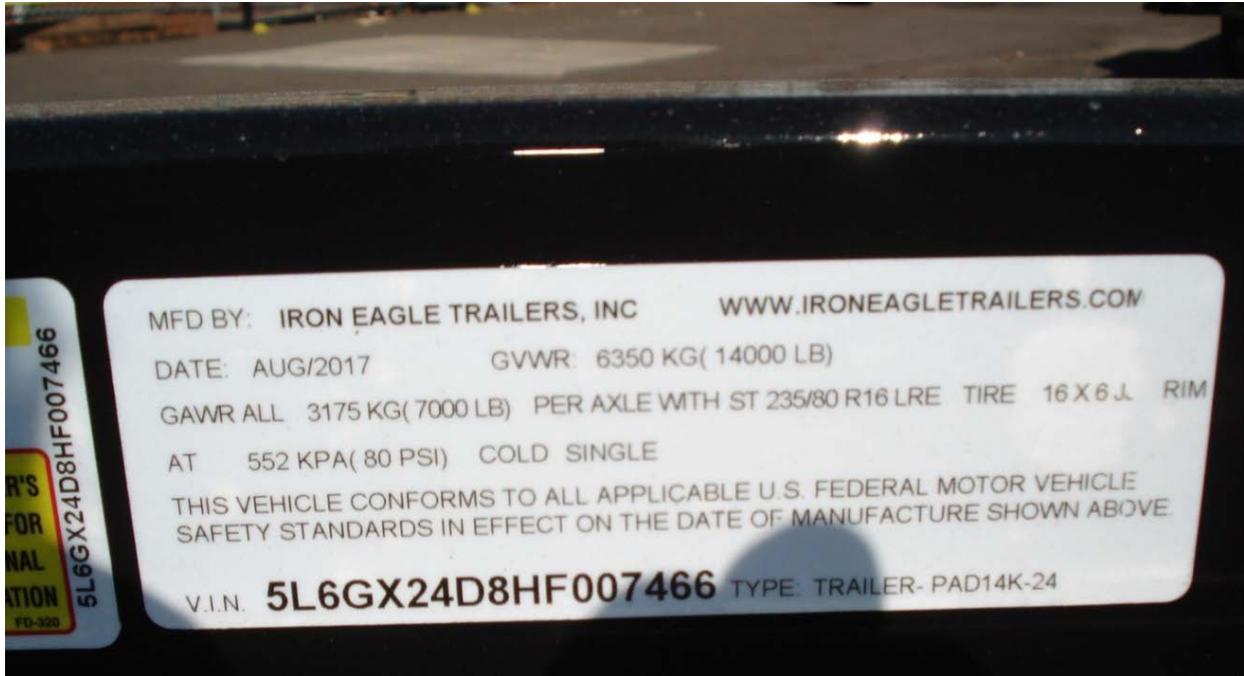
One of four corner scissor jacks welded to the trailer frame for quicker leveling of the trailer. A nice feature if the THOW will be moved often.

Features like scissor jacks are handy during construction and for frequent moves, but can get in the way of infrequent movers, especially if skirting around the bottom of the trailer is added. Fender flashing is useful for some exterior wall designs but not for all. If used, the exact location of the welded flashing on the fender width is critical to allow for integration into the exterior wall system regardless if it is to be behind the exterior sheathing, water-resistive barrier (WRB), or exterior siding material. Metal pan bottoms usually have cutouts in each corner to act as drain holes so they need screening installed to keep insects out.

Common axle ratings and number of axles for trailers are one 5,000 pound rated axle, two 5,000 or 7,000 pound rated axles, or three 7,000 pound rated axles.



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Trailer with axles rated at 7,000 pounds each

Generally a tiny house specific trailer for a given length will cost about the same as a flatbed trailer of that same length, but weigh 10 to 20 percent less even though it is wider than the flatbed trailer. For example, a tiny house trailer 20 feet long with a metal bottom pan weighs about 1,800 pounds while a flatbed trailer 20 feet long is around 2,300 pounds. That leaves 500 additional pounds that can be allocated for the tiny house itself instead of the trailer. Due to the similar cost, lighter weight, and less work (no existing trailer decking removal and customization to attach tiny house walls and floors) a tiny house specific trailer is usually the way to go. The exception would be if there are no local or regional trailer manufacturers in your area since shipping costs range from \$750 to \$1,500 depending on distance. Refer to Table 2 for typical tiny house specific trailer properties like weight, number of axles, and cost.



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Trailer Length	Typical Trailer Weight (pounds)	Typical Number of Axles	Typical Allowable Tiny House Weight (pounds)	Typical Cost Range ^{1, 2}
10' to 12'	1,000	1	5,000	\$2,200 to \$3,000
14' to 16'	1,500	2	10,000	\$3,200 to \$3,700
18' to 22'	1,600 to 1,850	2	10,000 to 14,000	\$3,700 to \$4,500
24' to 26'	1,900 to 2,000	2	14,000	\$4,500 to \$5,600
28' to 30'	2,600 to 27,00	3	21,000	\$5,900 to \$8,000

¹Typical Upgrade Costs:

Galvanized Sheet Metal Bottom Pan : Around \$20 per foot of trailer length

Scissors Jacks: \$200 to \$300 for a set of 4

Fender Flashing: \$100 to \$150 for both fenders

² Cost range does not include shipping so add shipping cost if applicable

Table 2: Typical Tiny House Specific Trailer Properties

Appliances

Appliances in a tiny house cannot be an afterthought. During the planning stage, designers and clients need to decide what appliances to include, the appliance sizes, and the appliance energy sources as this greatly influences floor plan layout and room size (sometimes even house size). A THOW will likely require tradeoffs, as only the longest trailer lengths will be able to accommodate all the appliances a traditional house has. Most gas appliances, except gas ranges, require direct venting to the outside so it is easiest and least costly to locate them near exterior walls.



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A tankless, or on-demand, propane hot water heater installed in a THOW. Notice the vent coming out the top of the unit. This water heater model plugs into a 120 volt electrical receptacle to power the flame igniter. Models with battery powered flame igniters are also sold.

Converter kits are sometimes sold to allow conversion of an appliance from natural gas (NG) to liquid propane (LP) or vice versa. Appliance prices can vary greatly depending on fuel source. Gas ranges, both NG and LP, can be found for prices similar to alternating current (AC) electric



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ranges. On the other hand, LP refrigerators usually cost about double a comparably sized AC refrigerator. Direct current (DC) electric appliances, which are usually powered by photovoltaic systems and/or battery banks, are very expensive. At the same time DC appliances are highly efficient. 2-way and 3-way appliances are able to run on multiple fuel sources and are the most expensive of all. The most common 2-way appliances run on LP and 120 volt AC while the most common 3-way appliances run on LP, 120 volt AC, and 12 or 24 volt DC. All tiny houses, but especially THOW and off-grid THOF can use either normal sized house appliances, RV appliances, or boat appliances. Many RV and boat appliances are 2-way appliances since they are transitory by nature. Off-grid tiny houses and frequently moved THOW are more likely to utilize a combination of gas and DC electric appliances. Tiny houses that are primarily stationary are more likely to use AC electric for most appliances. More detailed information, discussion, and sizing calculations for both appliances and heating/cooling systems will be presented in Part 4 of this course series. Table 3 shows appliance energy source options.

Appliance					Comment
	Electric (AC)	Electric (DC)	Propane	Natural Gas	
Refrigerator	X	X	X	X	
Range	X		X	X	
Cooktop	X		X	X	
Microwave	X	X			
Dishwasher	X				
Washer	X	X			Hand operated options exist
Dryer	X		X	X	Two alternatives...a clothes line or drying rack!
Washer/Dryer Combos	X	X	X	X	Gas combos usually use electricity for washing
Water Heater (Tank)	X	X	X	X	Solar hot water is a fifth potential source
Water Heater (Tankless)	X		X	X	

Table 3: Common Appliance Energy Source Options

Most THOW store their propane tank or tanks in an exterior storage cabinet on the front or back of the trailer. In addition to acting as the mechanical room these areas provide much needed storage. Some THOW use the plastic propane covers common to RV travel trailers. Multiple propane tanks allow for uninterrupted service and make refilling a tank less time urgent. Both manual and automatic changeover valves are sold to switch from one tank to the other. The changeover valve is often combined with the regulator that reduces high pressure propane in the tank to a much lower pressure that the appliances are designed to operate at. Regulators without



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changeover valves are also sold. Standard propane tank sizes are 20 pounds (holds 4.5 gallons and costs about \$40), 40 pounds (holds 9 gallons and costs about \$90), and 100 pounds (holds 23 gallons and costs about \$140). For reference, the 20 pound tank size is likely the size that came with your barbeque gas grill.



A changeover regulator is in the background



A 40-pound propane tank



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Storage cabinet on front of a THOW



RV style propane cover placed on the trailer tongue

THOW Utility Connections

The utility connections you need to plan for are dependent on the energy source choices made for appliances and heating/cooling systems as well as the toilet choice. Gas is usually stored in tanks attached to the THOW. Most campgrounds, trailer parks, and RV parks provide either or both 30 amp and 50 amp services. Plug adapters are inexpensive and easily obtainable if the electric service provided doesn't match the plug amperage chosen for the THOW.



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Left: A 50 amp electrical service connection to a fifth wheel RV

Right: An RV resort electrical hookup with the 50-amp receptacle on the left (where the cord is plugged in), 30-amp receptacle in the middle, and 20-amp convenience receptacle on the right

Even if a composting toilet is selected, a THOW still needs a gray water sewer connection and potable water connection for sinks and showers. If a flush toilet is used either separate gray and black water sewer connections will be needed or a combined gray and black water sewer connection.



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Left: A typical 3" diameter sewer connection on an RV. This hose has a "bayonet" style connection.

Right: An RV resort sewer hookup shared by two lots consisting of two hose connection points and a cleanout. Most in-ground discharge piping is 3", 3.5", or 4" diameter. Usually the RV hose kit comes with multiple adapters or a "stepped" adapter that fits all the typical pipe sizes encountered.

Most campground, trailer parks, and RV parks provide a hose bibb with a male connection that a drinking water hose can be connected to. Drinking water hoses are usually white, blue, or white and blue in color. All three common hose sizes (1/2", 5/8", and 3/4" inside diameters) have the same size fitting on the end and will connect to a standard 3/4" hose bibb.



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Left: A typical potable water connection on an RV

Right: An RV resort potable water hose bibb with a granular activated carbon filter attached between the hose bibb and drinking water hose

Most of the time a designer will choose to make all utility connections more like a traditional house or, if the THOW is going to be mobile or placed in an RV park or resort, use RV utility connection parts. Part 4 of this course series will cover additional information on utility connections.



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From Left to Right: Gray water discharge connection for sink, potable water hose connection, potable cold water drain outlet used for winterization of this THOW

Floor Plans

Floor plans for tiny houses usually utilize the open floor plan concept meaning they have few interior partition walls, especially between family, living, dining, and kitchen areas. Tiny houses also tend to utilize spaces for more than a single function by using transformable furniture like sleeper-sofas (Hide A Bed), wall beds (Murphy Beds), foot rests or coffee tables with built-in storage, foldable/removable dining tables, etc. This is true for both THOF and THOW. If you're looking for space saving and transformable design ideas consider concepts used in ships, RVs, and efficiency apartments. Or visit Ikea.

Four of the most common THOW floor plan arrangements are shown in Figures 1A to 1D. Three of these floorplans include lofts while one does not. Floor plans without lofts are more popular with older people and empty nesters downsizing with the intent of aging in place.

Figure 1A clusters the kitchen and bathroom together for efficient plumbing. The small, L-shaped kitchen likely means only one person can cook at a time. The loft above the bath and



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kitchen is for sleeping and the loft above the entry door for storage. Some people don't like using the food prep sink for teeth brushing or hand washing after bathroom use. Other people dislike the proximity of the toilet to the kitchen, especially when guests are over.

Figure 1B provides a bit of separation between the kitchen and bathroom which complicates plumbing somewhat as you either have to cross the axles with drain/waste pipe or have multiple drain/waste pipe discharges (more on that in in Part 4 of this course series). A small sink is included in the bathroom to alleviate germ concerns. The linear kitchen arrangement allows for multiple cooks. Two sleeping locations are available since there is a first floor bedroom and a loft above the bath and bedroom. The downside is the bed takes up the entire bedroom. There is also storage space in the loft over the entry door. The loft ladder can be moved between the two lofts.

Figure 1C provides maximum separation between the kitchen and bathroom which again complicates plumbing somewhat. The larger, L-shaped kitchen allows for multiple cooks and larger appliances, especially a full-height refrigerator, while maintaining sufficient kitchen counter space for prep work. The bathroom is large enough for a small tub instead of a shower. The loft above the kitchen is for sleeping and the loft above the bathroom is for a home office or storage. The tradeoff for a larger kitchen and bathroom is a smaller great room.

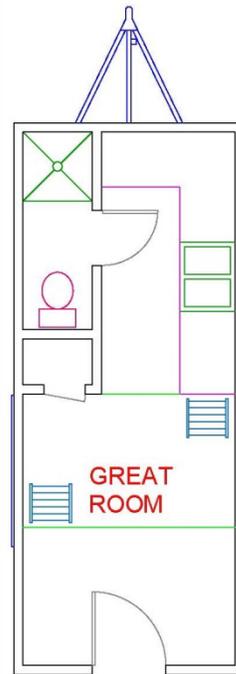


Figure 1A

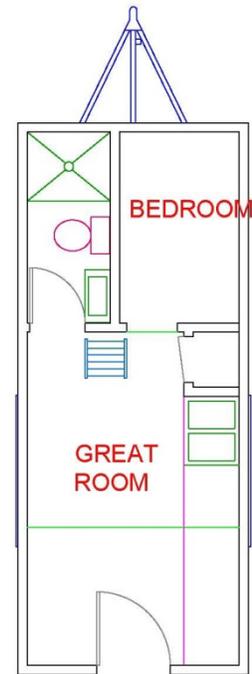


Figure 1B

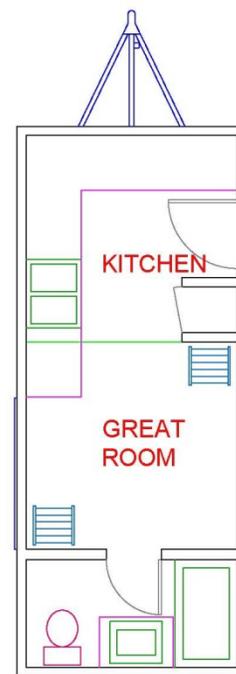


Figure 1C



Figure 1D



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Figure 1D clusters the kitchen and bathroom together for efficient plumbing. Again some people find this close proximity as a negative. There is no separate sink in the bathroom. The small, L-shaped kitchen likely means only one person can cook at a time. The bed does not take up the entire bedroom making it easier to exit the bed in general and even more so without disturbing another sleeper in the bed. There are no lofts which is a feature many older adults appreciate. French doors (or slider if preferred) bring lots of light into the great room, improve views, and provide connection to the outdoors.

Regardless of the general floor plan layout preferred there are many items to specifically plan for prior to finalizing the final layout and dimensions. Due to the limited space available in tiny houses, many items' storage locations can't be afterthoughts like they are in larger houses. These items may include:

- Clothing storage: hanging clothes, folded clothes, coats, shoes, etc.
- Clothing preparation and laundry storage: dirty laundry hamper, iron, ironing board, etc.
- Cleaning supply storage: vacuum, broom, household cleaners, etc.
- Food storage: produce, fresh fruits and vegetables, dry goods and cans, spices, etc.
- Small appliances: toaster, food processor, juicer, blender, coffee maker, mixer, etc. Most of these are electric appliances so if the tiny house is not grid-tied it will take a larger photovoltaic system to power them.
- Dish storage: plates, bowls, glasses, mugs, silverware, pots, pans, baking sheets, strainers, cooking utensils, etc.
- Food preparation storage: hot pads, hot plates, cutting boards, knife set, mixing bowls, can opener, recipe books, etc.
- Miscellaneous storage: garbage can, recycling bin, fire extinguisher, trash bags, Tupperware, zip lock bags, aluminum foil, plastic wrap, wax paper, first aid kit, medications, etc.
- Tool and maintenance storage: home repair tools, auto repair tools, gardening tools, etc.
- Work and leisure storage: computers or laptops, printer, modem, router, books, exercise equipment, etc.

Section Views

Two common THOW sections, one with a gable roof and one with a shed roof are shown in Figure 2.



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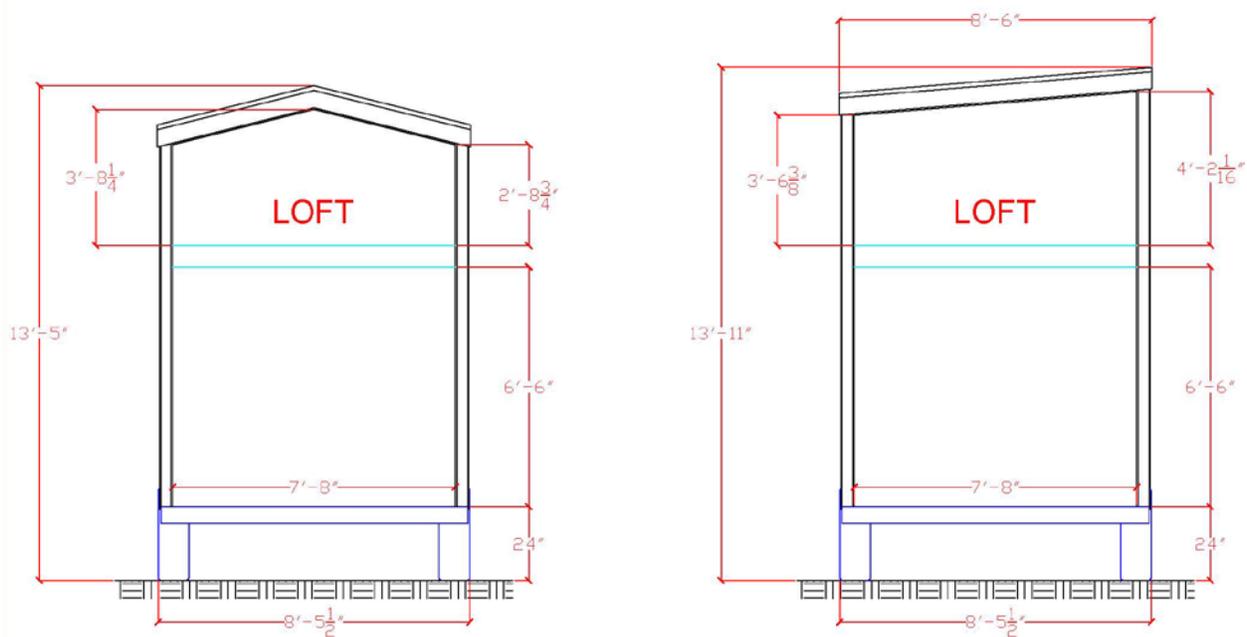


Figure 2: Two Common Sections for THOW

Originally access to THOW lofts was primarily by ladders. In recent years stairs have become popular as well. On the plus side stairs are usually easier to traverse and safer compared to ladders. The biggest negative is they take up much more space than a ladder and limit window placement on the stair wall. Some of the loss of space is made up for by built-in storage under the staircase. Figure 3 shows an example THOW with two lofts, one with stair access and the other with ladder access, that comply with the dimensional requirements of IRC Appendix Q. The figure also shows the stair landing platform Appendix Q requires. The intent of the landing platform requirement is to ease the transition from the stairs to the loft since the loft height most likely will require an inhabitant to traverse the loft on their knees. Realistically a two-loft THOW with stair access to one loft will require a trailer at least 20 feet long and often you won't see stairs in models unless they are 24 feet or longer. Wheel well projection into the interior space also sometimes conflicts with stair placement, especially with shorter trailers. If you are using a tiny house specific trailer the manufacturer can adjust the location of the wheels slightly to help the stairs fit better, but there is a limit how much the wheels can be moved without causing problems with balance and bouncing during movement. Also you need to make sure if you have a ceiling fan in the vaulted area between the lofts that you can access both lofts without running into the fan.



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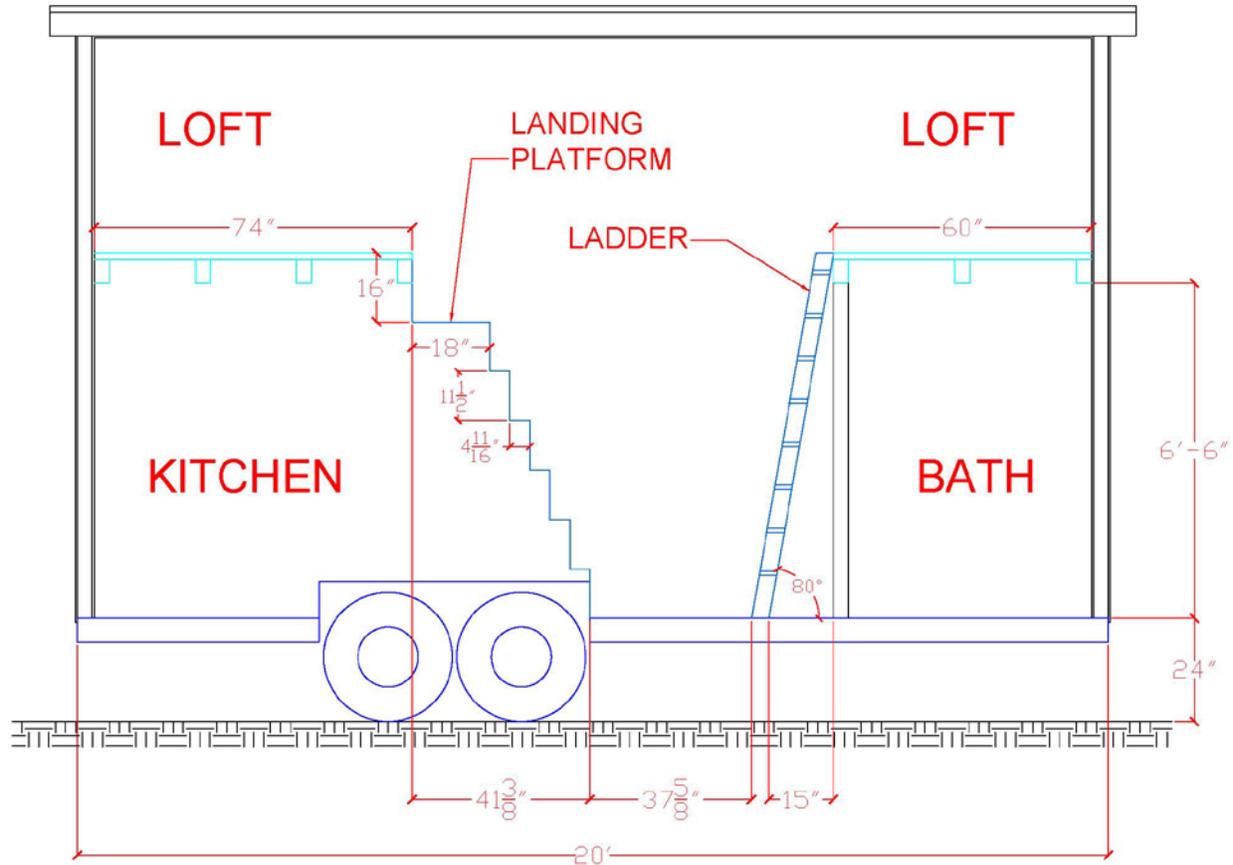


Figure 3: Example Stair and Ladder Access to Lofts

Floorplan possibilities are endless and not everyone agrees on what features are pros and which features are cons. As a result the designer must work out a floorplan that is conducive to the client's wants, needs, and lifestyle.

Making Spaces Feel Larger

Since space is at a premium in tiny houses it is helpful to make the space feel bigger than it is. This can be accomplished by:

- Using transformable furniture
- Increasing sunlight into the space through the use of lots of windows and doors with glazing
- Creating sightlines from one end of the structure to the other end
- Using light colors for the interior



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- Selecting striped décor to elongate perceived distances
- Buying a clear shower curtain
- Placing mirrors on the walls or ceilings
- Specifying distributed lighting instead of a single light fixture in each room
- Buying or constructing furniture or built-in furniture with legs
- Increasing ceiling heights (for THOW by building the tiny house taller, see [Maximum Width, Height, and Length without Permits](#) section)
- Increase ceiling heights through your selection of roof type and roof pitch
- Connecting to outdoor living spaces using double doors, French doors, or sliding glass doors

Lofts

Lofts in houses are nothing new. They were quite popular in early American log cabins, especially sleeping lofts. In recent decades they have been relegated mostly to storage purposes in traditional sized homes with the exception of high ceiling lofts used in open floor plans. Lofts are popular with many tiny house occupants because they multiply useable space without an increase in building footprint. Major challenges for lofts in tiny houses include the difficulty of providing adequate ingress/egress, emergency escape, and headroom.



Loft used as a living room in a THOW



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Loft used as a bedroom in a THOW

There is often confusion surrounding what normal and emergency ingress/egress (entry/exit) is required for a sleeping loft so let's try and clear up that confusion. The everyday, normal way someone leaves a loft is the *means of egress*. In an emergency situation like a fire, someone would first try and use the normal *means of egress* to escape. If that path is blocked a second option is required for certain room uses and sleeping rooms are one of those uses. Unless a second *means of egress* or automatic sprinkler systems are installed, every sleeping room requires at least one operable *emergency escape and rescue opening* (see IRC R310.1). An *emergency escape and rescue opening* is defined by the IRC as "An operable exterior window, door or similar device that provides for a means of escape and access for rescue in the event of an emergency." When a window is used for an *emergency escape and rescue opening* the sill height must be 44 inches or less above the floor (IRC R310.2.2). The window must also provide a net clear opening size of 5.7 square feet, a net clear height opening of at least 24 inches, and a net clear width opening of at least 20 inches (IRC R310.2.1). There is an exception that allows the net clear opening size of 5.7 square feet to be reduced to 5 square feet in certain circumstances.

So a sleeping loft needs not only to provide a *means of egress* (IRC R311.1), which is a continuous and unobstructed path to an *egress door* (the door used to enter and exit the tiny house), but also an *emergency escape and rescue opening*. The 2018 IRC always allows stairways (IRC R311.7) as a *means of egress* for sleeping lofts; however, it only allows



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alternating stair devices (IRC R311.7.11) and ships ladders (IRC R311.7.12) as *means of egress* for sleeping lofts if the loft is 200 square feet or less. This 200 square feet limit is not usually an issue for tiny house lofts as they are rarely, if ever, over that threshold. IRC Appendix Q further relaxes the requirements for *means of egress* using stairways, alternating stair devices, and ships ladders. It also allows regular ladders as a *means of egress* as long as dimensional and incline requirements are met (IRC AQ104.2.2). Since low height ceiling lofts often don't have adequate wall height for a door or a sufficiently sized window that qualifies as an *emergency escape and rescue opening*, a provision was placed in IRC Appendix Q allowing skylights and roof windows to qualify as *emergency escape and rescue openings* if certain dimensional requirements are met (see IRC AQ105.1 and AQ102.1).

Design lofts to have a minimum floor area of 35 square feet and minimum horizontal floor dimensions of 5 feet to meet IRC Appendix Q requirements. When space is tight in a front loft some builders cantilever a portion of the loft over the trailer tongue to gain an extra foot or two. Two good rules of thumb for determining adequate ceiling height in lofts are: 1) Ensure the tallest occupant can place both knees on the loft floor, keep their back straight, and have at least three inches of clear space between the top of their head and the ceiling and 2) Ensure the tallest occupant can sit on an object (a bed mattress, beanbag chair, or whatever is being used in that loft), keep their back straight, and have at least three inches of clear space between the top of their head and the ceiling. For mass produced trailer models, assume a person six feet tall.

Ladders can be especially hard to navigate at night when it is dark and drowsy sleepers wake up to use the bathroom facilities. Consider adding an electrical receptacle on the wall adjacent to every ladder accessing a loft. Place the receptacle at a height at least 6 inches below the loft floor. The receptacle can then be used to plug in a nightlight (preferably with a red light) that is not visible from the mattress, but is visible as you approach the ladder near the edge of the loft.



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Left: Loft ladder with one leg standing on a framed out wheel well

Right: Spiral loft ladder with custom metal frame to take up less floor space

Conclusion

This first course provided a general overview of the legality, placement, and standards for tiny houses. Basic planning and design considerations for the trailer, appliances, utility connections, floor plans, and lofts were also discussed.



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Remember there are three more courses in this series. These subsequent courses have many more pictures, example calculations, and drawings. Course two goes over specific structural design considerations for floor systems, walls, headers, and roof systems. Both prescriptive and engineered methodologies are included. How to structurally handle the mobile nature of THOW is also covered. Course three will focus on the remaining building enclosure components: ventilation, siding, doors, windows, interior finishes, insulation, and air sealing. Course four will discuss mechanical, electrical, and plumbing (MEP) systems with an emphasis on going off-grid or mobile with a tiny house. Look for courses three and four to be released in late 2019 or early 2020.

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