The City of Lee's Summit

Final Agenda

Community and Economic Development Committee

Wednesday, November 14, 2018

4:00 PM

City Council Chambers
City Hall
220 SE Green Street
Lee's Summit, MO 64063

1. Call to Order
2. Roll Call
3. Approval of Agenda
4. Approval of Action Letter

   A. 2018-2376 Approval of the October 10, 2018 Community and Economic Development Committee Minutes.

5. Public Comments
6. Business

   A. 2018-2419 Presentation and Discussion - Targeted Industries for Lee's Summit - Lee's Summit Economic Development Council

   Presenter: Rick McDowell, Lee's Summit Economic Development Council President

   B. 2018-2374 Recommendations for the adoption of the 2018 International Residential Code (IRC)

   Presenter: Dan Harper, Mike Copeland, Tracy Diester

   C. TMP-0996 Adoption of the 2018 Property Maintenance Code

   Presenter: Dan Harper and Tracy Deister

   D. 2018-2408 Application #PL2018-194 Unified Development Ordinance Amendment #3 - Article 6 Use Standards - Accessory Uses and Structures - Table 6.IV-1. Accessory Structures - Amending Detached Garage Size Limitations in All Residential Districts; City of Lee's Summit Applicant

   Presenter: Presenter: Robert McKay, AICP, Director of Planning and Special Projects

7. Roundtable
8. Adjournment

For your convenience, City Council agendas, as well as videos of City Council and Council Committee meetings, may be viewed on the City's Legislative Information Center website at "lsmo.legistar.com"

Packet Information

File #: 2018-2376, **Version:** 1

Approval of the October 10, 2018 Community and Economic Development Committee Minutes.

LEE'S SUMMIT
MISSOURI

The City of Lee's Summit

Action Letter

Community and Economic Development Committee

Wednesday, October 10, 2018

4:00 PM

City Council Chambers
City Hall
220 SE Green Street
Lee's Summit, MO 64063

Call to Order

Roll Call

Present: 4 - Vice Chair Diane Forte
Councilmember Fred DeMoro
Liaison Donnie Funk
Councilmember Craig Faith

Absent: 2 - Chairperson Beto Lopez
Alternate Bob Johnson

Approval of Agenda

A motion was made by Councilmember Faith, seconded by Councilmember DeMoro, that this agenda be approved. The motion carried unanimously.

Approval of Action Letter

2018-2366 Approval of the September 12, 2018 Community and Economic Development Committee action letter.

A motion was made by Councilmember DeMoro, seconded by Councilmember Faith, that this action letter be approved. The motion carried unanimously.

Public Comments

There were no public comments presented at the meeting.

Items for Discussion

2018-2310 Discussion on Project Progression from Preliminary Development Plan to Final Development Plan

This was a presentation given by Josh Johnson, Assistant Director of Plan Services.

2018-2354 UDO Amendment Priorities

This was a presentation given by Josh Johnson, Assistant Director of Plan Services.

Business

Roundtable

Diane Forte announced that the next CEDC meeting would be held on November 14. Mark Dunning welcomed David Bushek. Mr. Bushek is the new Chief Counsel of Economic Development and Planning. Mr. Dunning stated that the meeting on November 14 will involve significant business and that the CEDC members should expect it to be a lengthy meeting. Ryan Elam commented that the Board of Appeals has been looking at the 2018 Property Maintenance Code, Residential Code, and Commercial Codes. This will come to the CEDC meeting on November 14.

Adjournment

There being no further business, Vice Chair Forte adjourned the meeting at 5:10 pm.

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Packet Information

File #: 2018-2419, **Version:** 1

Presentation and Discussion - Targeted Industries for Lee's Summit - Lee's Summit Economic Development Council

Issue/Request:
Presentation and Discussion - Targeted Industries for Lee's Summit - Lee's Summit Economic Development Council

Key Issues:
Rick McDowell, President of the Lee's Summit Economic Development Council (LSEDC) will be providing the Committee with a presentation and overview of the Economic Development Market Study conducted in 2015-2016 regarding targeted industries for Lee's Summit.

Background:
In 2015-2016 the LSEDC engaged North Star Destination Strategies to conduct economic development market research. the data identified industries and industry clusters that are best suited to Lee's Summit's existing business climate based on a variety of factors including regional growth industries, workforce attributes and demographic and household data. This research is designed to assist in efforts to hone in on the most qualified business prospects nationwide using a variety of findings uncovered by traditional studies such as cluster analysis and targeting.

Rick McDowell, Lee's Summit Economic Development Council President

Target Industries

Lee's Summit Economic Development Council is focused on recruiting companies with high capital investment and job creation.

These target industries include:

- Health & Medical
- Animal Health Science
- Data Centers
- Manufacturing & Distribution
- Aerospace
- Office/Headquarters.

LS
Plug Into
Lee's Summit
The City of Lee's Summit, Missouri is home to the Summit Technology Campus, a 1-million-square foot technology park that is home to two national data center tenants, Sprint and Cerner Corporation. STC offers redundant and affordable power and plentiful connectivity in a highly secure facility that is ideal for data centers, disaster recovery facilities and telecom switching. Located in suburban Kansas City, Missouri, STC tenants enjoy a centralized U.S. location with immediate highway access and targeted workforce.
STC's Features:
- Dual Grid Primary Feeds supported from two full-capacity 161 KV feeders
- Tier One Fiber Providers including AT& T, Time Warner and Century Link
- 100% Reliability with no outages for more than 15 years
- Flexible Space divisible into units as small as 5,000 square feet
- 24/7 Security includes both foot and vehicle patrols

The Lee's Summit Advantage

- **Diverse economy:** 5,000 + thriving businesses
- **Fastest growing city in Missouri:** approximately 96,000 residents
- **Average household income:** $77,000
- **Award-winning schools:** Ranked in Top 25 by US News and World Report
- **Educated workforce:** 93% HS graduation rate, 40% hold bachelor's degree
- **Business friendly:** Targed incentives available

KANSAS CITY METROPOLITAN AREA SITE MAP

Connect With Us:

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President & CEO
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RMcDowell@LeesSummit.org

LEE'S SUMMIT
ECONOMIC DEVELOPMENT COUNCIL

NORTH STAR

Cluster Portfolio

13
Traded Clusters

- Communications 1.42k
- Distribution & eCommerce 28.0k
- Downstream Metals 4.34k
- Electric Power 750
- Environmental Services 278
- Financial Services 6.56k
- Insurance 5.75k
- Marketing 4.16k
- Paper & Packaging 1.84k
- Performing Arts 1.54k
- Printing 5.66k
- Recreational Goods 3.83k
- Upstream Chemicals 940

Industry Strengths

Industries

- BIOSCIENCES
- CONTACT CENTERS
- DATA CENTERS
- DISTRIBUTION
- ECOMMERCE
- FINANCIAL SERVICES
- HEADQUARTERS
- MANUFACTURING
- AUTO MANUFACTURING
- TECHNOLOGY

For more information contact:

JILL McCARTHY
Senior Executive
Corporate Attraction
816.374.5636

The Kansas City area economy is supported by a wide variety of businesses, and is a national leader of several key industries which are integral to KC's regional economic growth.

KC has long been a leading center of transportation and distribution, eCommerce, manufacturing, animal health, technology and the financial industry. Our utility and telecommunications infrastructure has enabled KC to develop a number of successful data center and contact center operations. As one of the largest and most philanthropic metros in the Midwest, KC is also an ideal location for corporate headquarters operations.

Missouri's Target Industries

With the 3rd most diverse economy, one of the lowest costs of living, a central location, and home to a highly-skilled and educated workforce, Missouri provides the perfect environment along with the necessary assets to help businesses succeed. To build up and attract some of the fastest-growing industries and leaders in next-generation job creation, such as tech and energy solutions, Missouri refocused its resources to target companies in the following sectors:

Automotive Suppliers

With historic investments by Ford and GM, the rebirth of the automotive industry is happening in Missouri. Become part of one of the largest auto supply chains in the nation where America's top vehicles, like the Ford F-150 and the Chevy Colorado, are assembled.

Biosciences

Missouri is home to the largest concentration of animal health research and food companies as well as the most plant scientists per capita. This is where innovation starts and thrives.

Energy Solutions

Whether you're in the business of energy production or storage, Missouri's high-tech environment, natural resources, and central location make it easier to connect to the grid affordably and efficiently.

- Advanced Manufacturing
- Financial & Professional Services
- Health Sciences & Services
- Information Technology
- Transportation & Logistics

ECONOMIC DEVELOPMENT MARKET STUDY
LEE'S SUMMIT, MISSOURI

2015-2016

NORTH STAR DESTINATION STRATEGIES

COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

ECONOMIC DEVELOPMENT MARKET STUDY
LEE'S SUMMIT, MISSOURI

2015-2016

Prepared for:
Lee's Summit Economic Development Council
218 SE Main Street
Lee's Summit, MO 64063

Research Conducted by:
North Star Destination Strategies

Report Compiled by:
Lee's Summit Economic Development Council

TABLE OF CONTENTS

INTRODUCTION

About North Star, Lee’s Summit and this Project

North Star Destination Strategies has been working exclusively with communities for more than a decade, helping them uncover, define, implement and integrate their own unique competitive identities.

In 2011, the City of Lee’s Summit, MO partnered with North Star on a community branding project. Through comprehensive research, the initiative uncovered a competitive identity based on Lee’s Summit’s most relevant and distinct promise to its stakeholders—those who live, work and play in Lee’s Summit. The strategic platform that resulted from the initiative states, “For those seeking unassuming, community-minded neighbors, Lee’s Summit, the highest point between Kansas City and St. Louis, affords you a broader perspective on what’s important so you can go above and belong,” The tagline chosen to represent the brand positioning is “Yours Truly.”

In 2014, Lee’s Summit again partnered with North Star to evaluate brand marketing efforts and awareness by understanding current public perceptions of Lee’s Summit and the extent to which Lee’s Summit’s reputation has changed since marketing efforts were put into place. The insights gleaned from North Star’s in-depth process of analyzing the resulting data illustrated the extent to which branding efforts have been successful in influencing public perceptions of Lee’s Summit and the extent to which Lee’s Summit’s brand image has changed.

In 2015, the Lee’s Summit Chamber and Lee’s Summit Economic Development Council again enlisted North Star’s expertise to conduct economic development market research. The data identified industries and industry clusters that are best suited to Lee’s Summit’s existing business climate based on a variety of factors including regional growth industries, workforce attributes and demographic and household data. The research identified Lee’s Summit’s labor force and consumption profile utilizing data gathered from Environmental Systems Research Institute Inc. (ESRI), Tapestry Profile, which incorporates more than 200 geo-demographics, socio-economic, lifestyle, workforce and psychographic data points.

North Star’s research is designed to help the Lee’s Summit economic development team hone in on the most qualified business prospects nationwide using a variety of findings uncovered by traditional studies such as cluster analysis and targeting.

PURPOSE AND METHODOLOGY

North Star's research is designed to uncover industries and clusters that best correspond and complement successful, high growth industries in Lee's Summit, Missouri. This research component should be used to identify potential business prospects for recruitment, expansion or retention efforts based on industries that are succeeding in Lee's Summit and in communities with a similar economic and psychographic footprint. This data can be used to assist economic development professionals and leadership within the area to actively recruit businesses and industries to the City of Lee's Summit.

Using data gathered from Environmental Systems industries (ESRI), North Star developed a demographic and psychographic profile for Lee's Summit. North Star then identified complementary communities that most closely share similar consumer characteristics. Using the Bureau of Labor Statistics, Quarterly Census of Employment and Wages data, North Star identified the top growth industries.

North Star's approach was to examine long run and short-run net positive growth exhibited by industry sectors in terms of employment, firms and wages. From this analysis, North Star determined the top industry sectors—listed using the North American Industry Classification System (NAICS)—within Lee's Summit's economic landscape. These industries were then compared to those of complementary communities around the country. This allows researchers to compare Lee's Summit's economic growth to communities with similar economic profiles as well as determine other high potential industries that may not have been targeted previously.

North Star combined Lee's Summit's top NAICS codes and the city's workforce characteristics (using Resident Tapestry data derived from ESRI) to define a list of targeted industries that best match the city's existing business assets and labor market strengths.

For additional information and a full description of NAICS codes, see: http://www.census.gov/eos/www/naics/ .

STUDY SUMMARY

The 2015-2016 Lee's Summit Economic Development Market study provided fundamental information about the Lee's Summit community and its demographic profile, its general business climate and employment base, as well as potential areas of growth and investment.

The data helped identify significant industry clusters, including advanced manufacturing and technology as well as aviation-related companies. In addition, Lee's Summit's core demographic profile has shifted slightly in the years after the Great Recession with the rise of the dual income, community-minded "Soccer Mom Family."

The information obtained from this market study will help the Lee's Summit Economic Development Council fine-tune its economic development strategy to attract new industry to Lee's Summit while identifying growth opportunities.

Lee's Summit Business Landscape

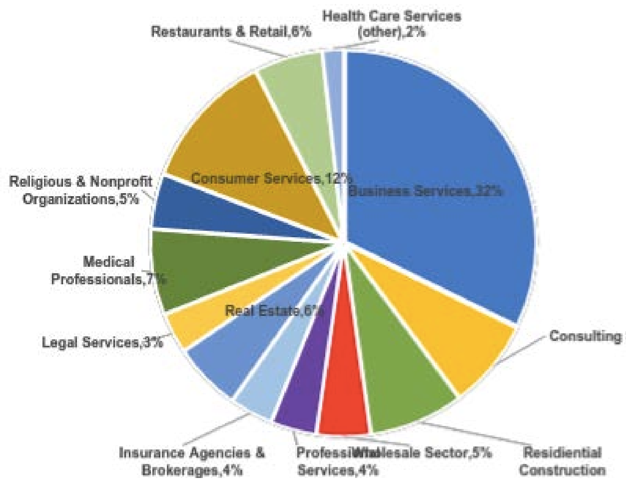
LEE'S SUMMIT BUSINESS LANDSCAPE
TOP INDUSTRIES: FIRMS

North Star identified successful, high growth industries in Lee's Summit, Missouri. The data should be considered an important first step when targeting companies for economic development recruitment, expansion and retention efforts.

As part of the review of Lee's Summit's businesses, North Star conducted a review of all businesses that were either a headquarters or single location within the city limits utilizing our Dun & Bradstreet database. This resulted in the identification of approximately 5,700 companies with the top industries represented in the graph below.

Lee's Summit's top growth industries are in the business services and consulting services in management services that includes health care and financial management. Together, they account for nearly 39 percent of the city's businesses. The top growth sectors account for approximately 40 percent of all businesses in the city, as indicated in the pie chart below. *Note: Information is based on Dun & Bradstreet (D&B) business research and profiling.*

Lee's Summit Top Industries: Firms

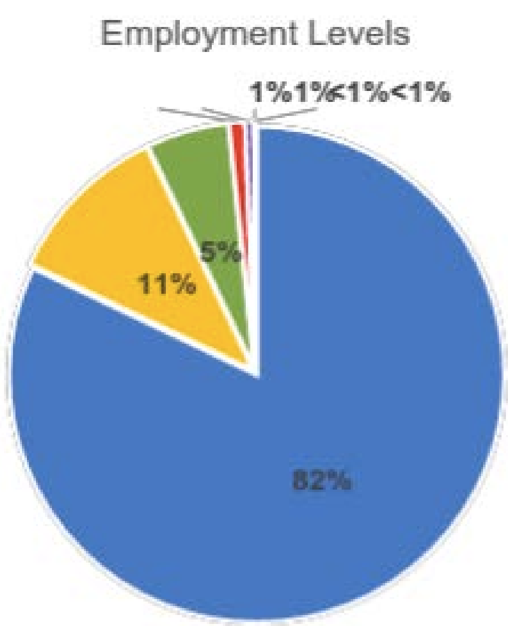


Number of Companies by Top Industry	
Business Services	1,053
Consulting Services	246
Residential Construction Contractors	261
Wholesale Sector	148
Professional Services	126
Insurance Agencies & Brokerages	120
Real Estate	188

LEE'S SUMMIT BUSINESS LANDSCAPE
TOP INDUSTRIES: EMPLOYMENT

With a total of 5,718 business licenses issued, the overwhelming majority of Lee's Summit companies (4,168) employ fewer than four employees, followed by companies who fall into the 5-10 employee range (550). Approximately 275 companies employ 11-49 people, with 86 having 50 or more employees.

Employment Level by Company	
< 4	4,168
5 - 10	550
11 - 49	275
50 -99	52
100 - 499	30
500 - 999	2
1,000 - 4,999	2



LEE'S SUMMIT BUSINESS LANDSCAPE
TOP INDUSTRIES: REVENUE

Over 94 percent of Lee's Summit businesses report revenue below $1 million. These are typically small businesses and enterprises that may be indicative of an entrepreneurial climate. A small portion of businesses in (5%) report revenue between $1 – $5 million. According to Dun & Bradstreet, a little over one percent of companies in Lee's Summit (1.3%) indicated having revenue over $5 million.

Revenue	
< $1 million	4,860
$1 - 5 million	235
$5 - $10 million	36
$10 - $50 million	26
$50 - $500 million	6
> $1 billion	1

LEE'S SUMMIT BUSINESS LANDSCAPE
TOP INDUSTRIES FOR RECRUITMENT BY NAICS CODE

NAICS Code	Industry
5415	Computer systems design and related services
5511	Management of companies and enterprises
5242	Insurance agencies and brokerages
48 & 49 (48412,486, 493)	Transportation & warehousing
5412, 54133, 54138, 5414, 5416, 5417	Professional, scientific, and technical services
6215, 623	Medical and diagnostic Laboratories/Nursing & Residential care
51 (5112, 51821)	Information sectors, particular related software and data warehousing
52232, 523, 524,525	Finance and Insurance
332	Fabricated metal manufacturing
311/312	Ag/food manufacturing
325/33911	Chemical manufacturing/pharma/medical device

Lee's Summit Top Industries: Conclusion

Given that a large percentage of Lee's Summit businesses operate with fewer than four employees, North Star concluded that the heart of the city's economic landscape is paved with small businesses and entrepreneurial enterprises.

Jackson County Economic Landscape

COUNTY AND STATE ECONOMIC LANDSCAPE
REGIONAL PERFORMANCE OUTCOMES

Jackson County, Mo. and the State of Missouri

Regional economic performance can be measured by indicators of overall performance directly related to the standard of living in a region, as well as intermediate indicators of economic activity that may or may not translate into a region's standard of living. Below find data on a variety of factors from 1998-2014 for Jackson County and the State of Missouri in benchmarks ranging from workforce to innovation.

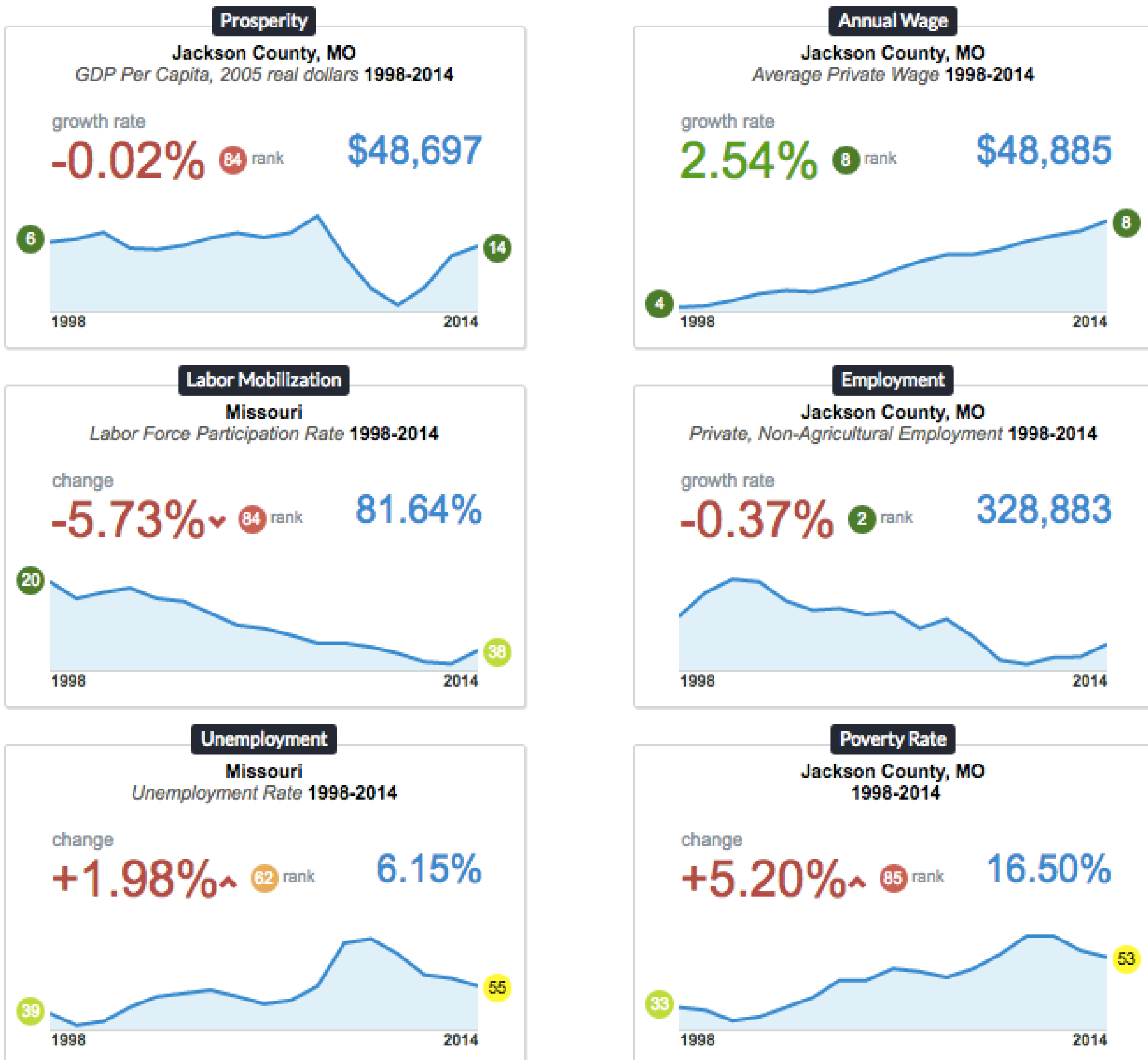
Key takeaways from the data for Jackson County, Mo:

•**Private wage growth** rose 2.54 percent, ranking Jackson County 8th among counties tracked.
•**GDP per capita** dropped by .02 percent, to $48, 697.
•**The employment rate** dropped just .37 percent, at No. 2 among peers, with a workforce of 328,883.
•**The poverty rate** rose 5.2 percent, with 16.5 percent of residents living in poverty.
•**Innovation growth rate** was 2.55 percent, with 1.91 utility patents per 10,000 employees (2005-2011)
•**The total number of business establishments** dropped by 116, with 17,961 total businesses.

Key takeaways for the State of Missouri:

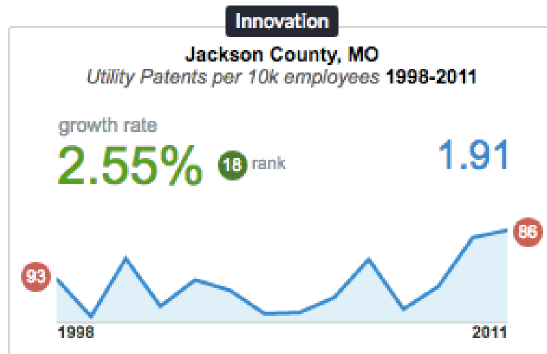
•**The labor force participation rate** dropped by almost 6 percent, at 81.64 percent participation.
•**The unemployment rate** rose by almost 2 percent, to 6.15 percent.
•**Labor force productivity** rose .76 percent, to $75,367 GDP per worker.
•**Exports as a percent of GDP** rose 4.7 percent to 6.17 percent.

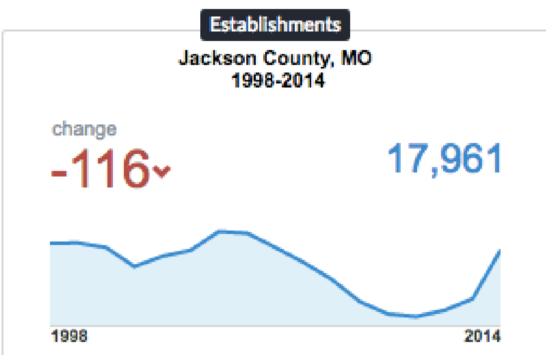
Outcomes



Prosperity
Jackson County, MO
GDP Per Capita, 2005 real dollars 1998-2014
growth rate
-0.02%
84 rank
$48,697
6
14
1998
2014
Annual Wage
Jackson County, MO
Average Private Wage 1998-2014
growth rate
2.54%
8 rank
$48,885
4
8
1998
2014
Labor Mobilization
Missouri
Labor Force Participation Rate 1998-2014
change
-5.73%
84 rank
81.64%
20
38
1998
2014
Employment
Jackson County, MO
Private, Non-Agricultural Employment 1998-2014
growth rate
-0.37%
2 rank
328,883
1998
2014
Unemployment
Missouri
Unemployment Rate 1998-2014
change
+1.98%
62 rank
6.15%
39
55
1998
2014
Poverty Rate
Jackson County, MO
1998-2014
change
+5.20%
85 rank
16.50%
33
53
1998
2014

Intermediate Outcomes





International Trade & Investment

COUNTY AND STATE ECONOMIC LANDSCAPE
BUSINESS ENVIRONMENT

Jackson County, Mo. and the State of Missouri

The first key driver of regional economic performance is the quality of a region's business environment, which is shaped by policy and firm behavior. Below find data on a variety of factors from 1998-2014 for Jackson County and the State of Missouri in benchmarks ranging from tax rates, venture capital expenditures and advanced degrees awarded.

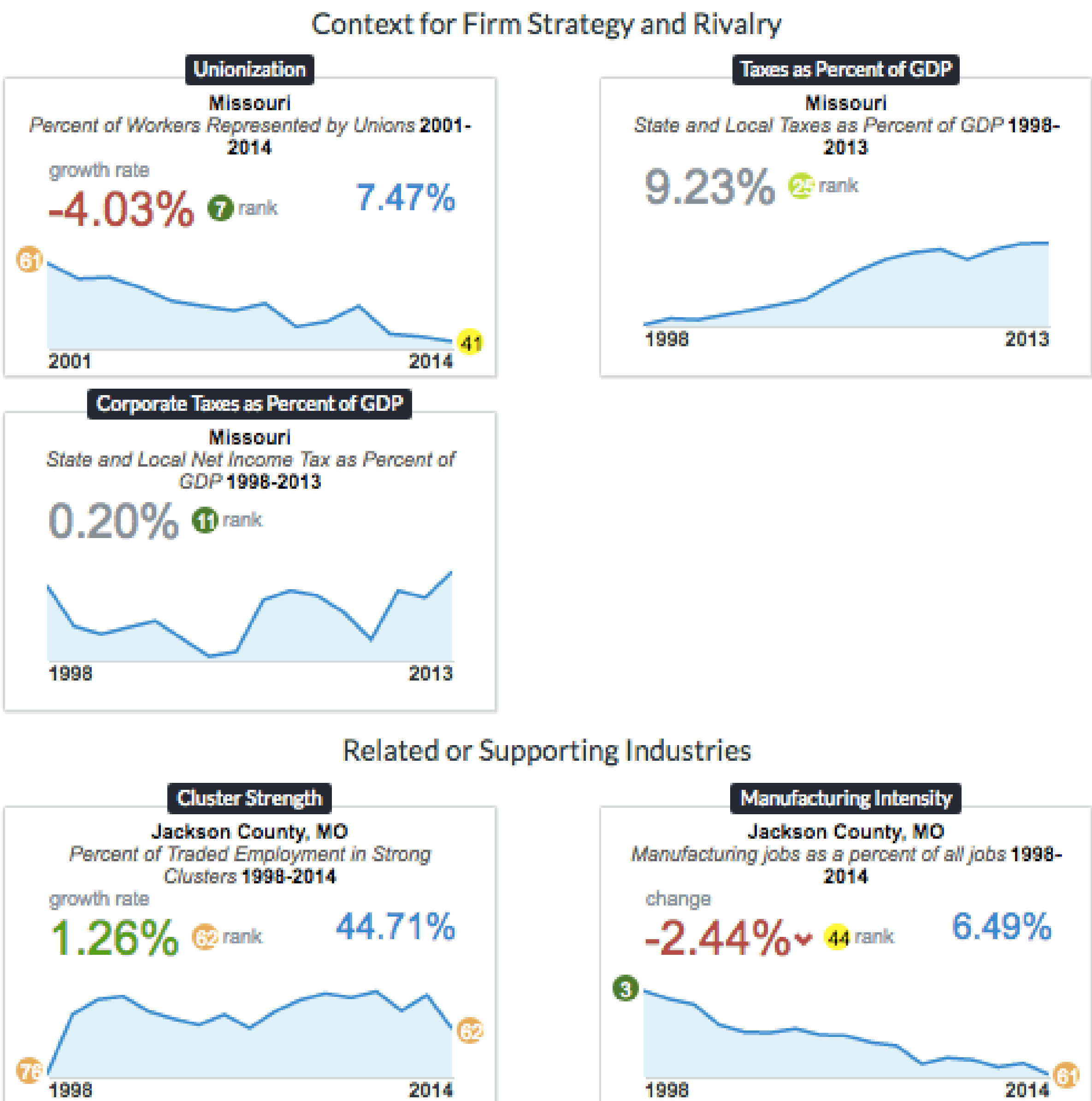
Key takeaways from the data for Jackson County, Mo:
Areas of significant growth or strength compared to peer counties or states noted in blue.

•**Venture Capital** expenditures were $65 per $10,000 GDP, an 86.52 percent growth rate, ranking the county 9th among peer counties.
•**Percentage of population receiving a high school diploma or more** was 88.70 percent, higher than the U.S. average of 86.33 percent, ranking the county 34th among peers.
•**Percentage of population with some college of Associates Degree or more** was 59.21 percent, higher than the U.S. average of 58.37 percent, ranking the county 20th among peers.
•**Percentage of population completing a Bachelor's Degree or more** rose 28 percent, slightly lower than the U.S. average of 29.28 percent, ranking the county 16th among peers.
•**The percentage of traded employment in strong clusters** was 44.17 percent, a growth rate of 1.26 percent.
•**Manufacturing jobs as a percentage of all jobs** was 6.49 percent, a decrease of 2.44 percent.

Key takeaways for the State of Missouri:

•**Research and development expenditure** per capita was $1,312, an 8.84 percent growth rate, ranking the state 4th among peer states.
•**Federal funding for R&D per capita** was $92, a 3.85 percent growth rate.
•**The number of science and engineering degrees** awarded was 17,390, for a 28th ranking.
•**The number of advanced scientific workers** rose by .18 percent, for a 2.90 percent growth rate, ranking the state 16th among peers.
•**The percent of workers represented by unions** was 7.47 percent, a decline of 4.03 percent, ranking Missouri 7th among peers.
•**State and local taxes as a percent of GDP** were 9.23 percent, ranking the state 25th among peers.
•**Corporate taxes as a percent of GDP** were .20 percent, ranking the state 11th among peers.

Factor Input Conditions


Context for Firm Strategy and Rivalry
Unionization
Missouri
Percent of Workers Represented by Unions 2001-2014
growth rate
-4.03%
7 rank
7.47%
61
41
2001
2014
Taxes as Percent of GDP
Missouri
State and Local Taxes as Percent of GDP 1998-2013
9.23%
25 rank
1998
2013
Corporate Taxes as Percent of GDP
Missouri
State and Local Net Income Tax as Percent of GDP 1998-2013
0.20%
11 rank
1998
2013
Related or Supporting Industries
Cluster Strength
Jackson County, MO
Percent of Traded Employment in Strong Clusters 1998-2014
growth rate
1.26%
62 rank
44.71%
78
62
1998
2014
Manufacturing Intensity
Jackson County, MO
Manufacturing jobs as a percent of all jobs 1998-2014
change
-2.44%
44 rank
6.49%
3
61
1998
2014

COUNTY AND STATE ECONOMIC LANDSCAPE
TAX CLIMATE & FISCAL RESPONSIBILITY

TAX CLIMATE

State Business Tax Climate Index 2015

State	Overall Rank
Missouri	17
Kansas	22
Oklahoma	32

State and Local Tax Burden

State	Total Taxes Paid per Capita	Rank (1 is Highest Taxes)
Missouri	$2,298	33
Kansas	$2,566	24
Oklahoma	$2,143	34

Source: The Tax Foundation

FISCAL RESPONSIBILITY

State Debt per Capita (FY2010)

State	State Debt per Capita	Rank (1 is Highest Debt)
Missouri	$3,416	26
Kansas	$2,276	37
Oklahoma	$2,664	34

Source: The Tax Foundation

Missouri Credit Ratings

Moody's	Standard & Poor's	Fitch
AAA	AAA	AAA

COUNTY AND STATE ECONOMIC LANDSCAPE
TAX SUMMARY

TAX SUMMARY

	MISSOURI	KANSAS	OKLAHOMA
CORPORATE INCOME (EXCISE) TAX AND FRANCHISE TAXES	Corporate Income Tax Rate: 6.25% Franchise Tax: The franchise tax rate is 1/1/150 of 1% (.000067) for tax year 2015, and 0% for tax year 2016 and thereafter.	Corporate Income Tax Rate: 4% Franchise Tax: There is no franchise tax after 2010	Corporate Income Tax Rate: 6% Franchise Tax: $1.25 for each $1,000 of capital invested or used in Oklahoma
INDIVIDUAL INCOME TAX ON WAGES	Tiered beginning at 1.5% for the first $1,000 of income. Income of over $9,000 is taxed at 6%.	Taxed at a rate of 2.7% for $15,000 and below. All income above $15,000 is taxed at 4.6%	Six tiers up to $8,700 in income All income above $8,700 is taxed at 5.25%.
SALES TAX	State sales tax rate is 4.225% Local rates can push the total rate to 10.863%	State sales tax rate is 6.15% Local rates can push the total rate to 9.8%	State sales tax rate is 4.5% County rate up to 2% City rate up to 5%
PROPERTY TAX	Property is taxed at the local level.	Property is taxed at the local level.	Property is taxed at the local level.
UNEMPLOYMENT INSURANCE TAX	Taxable wage base: $13,000 New employer rate: 2.7% Experienced rate rage: 0.0% - 6.0%	Taxable wage base: $12,000 New employer rate: 4.0% Experienced rate rage: 0.0% - 5.4%	Taxable wage base: $18,700 New employer rate: 2.4% Experienced rate rage: 0.2% - 7.3%

COUNTY AND STATE ECONOMIC LANDSCAPE
MISSOURI CORPORATE INCOME TAX SUMMARY

Missouri	**Corporate Income Tax** • Tax rate is 6.25% • Basis for income is federal tax return **Franchise Tax** • Tax is based on the "par value of the corporation's outstanding shares and surplus". • This is defined as the "total assets or the par value of issued and outstanding capital stock, whichever is greater". • For capital stock with no par value, the value is $5.00 per share or actual value, whichever is higher • The franchise tax rate is 1/30 of 1% (.000333) for tax years 2011 and prior; 1/37 of 1% (.000270) for tax year 2012; 1/50 of 1% (.000200) for tax year 2013; 1/75 of 1% (.000133) for tax year 2014; 1/150 of 1% (.000067) for tax year 2015; and 0% for tax year 2016 and thereafter.

COUNTY AND STATE ECONOMIC LANDSCAPE
MISSOURI TAX INCENTIVES PROGRAMS

- Missouri Works
  - Facilitates creation of quality jobs based on specific criteria met by certain types of businesses

Program	Minimum New Jobs	Minimum New Private Capital Investment	Minimum Average Wage	Automatic Benefit
Zone Works (Note 1)	2	$100,000	80% of County Avg. Wage	WH, 5 or 6 years (Note 3)
Rural Works (Note 2)	2	$100,000	90% of County Avg. Wage	WH, 5 or 6 years (Note 3)
Statewide Works	10	N/A	90% of County Avg. Wage	WH, 5 or 6 years (Note 3)
Mega Works 120	100	N/A	120% of County Avg. Wage	6% of new payroll, 5 or 6 years (Note 3)
Mega Works 140	100	N/A	140%	7% of new payroll, 5 or 6 years (Note 3)

- Missouri Manufacturing Jobs Act
  - Allows qualified automotive manufacturing facilities or suppliers that bring innovative production lines to the state to retain withholding taxes
  - Must make a capital investment of at least $75,000 per retained job at the manufacturing facility within two years of beginning to retain withholding taxes or
  - Commit to make a capital investment of at least $50,000 per retained job at the facility for the modification or expansion of the manufacture of an existing product within two years of beginning to retain withholding taxes.
  - Businesses must submit a report documenting the retained jobs or new jobs created, the total payroll, and confirming that the business meets the health insurance requirements for new jobs.
- Business Use Incentives for Large Scale Development (BUILD)
  - An eligible industry in manufacturing, processing, assembly, research and development, agricultural processing or services in interstate commerce must invest a minimum of $15 million; or $10 million for an office industry (regional, national or international headquarters, telecommunications operations, computer operations, insurance companies or credit card billing and processing centers) in an economic development project; and
  - Create a minimum of 100 new jobs for eligible employees at the economic development project or a minimum of 500 jobs if the economic development project is an office industry or a minimum of 200 new jobs if the economic development project is an office industry located within a distressed community.
- Brownfield Redevelopment Program

Demographics

DEMOGRAPHICS
POPULATION TRENDS

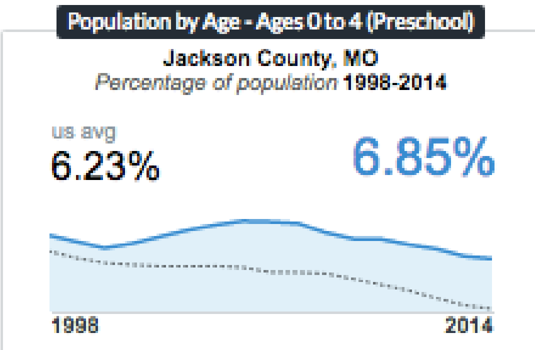
Jackson County, Mo. and State of Missouri

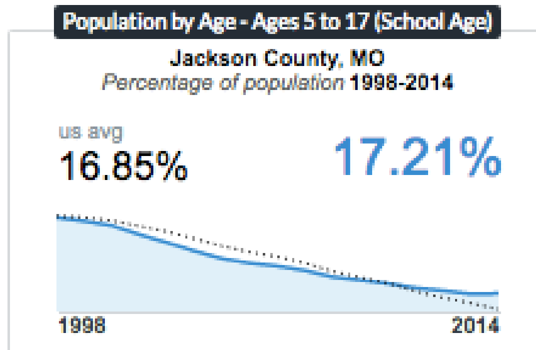
The second key driver of regional economic performance is a region's structure, which is largely shaped by population and demographic characteristics. Below find data on a variety of factors from 1998-2014 for Jackson County and the State of Missouri in benchmarks ranging from tax rates, venture capital expenditures and advanced degrees awarded.

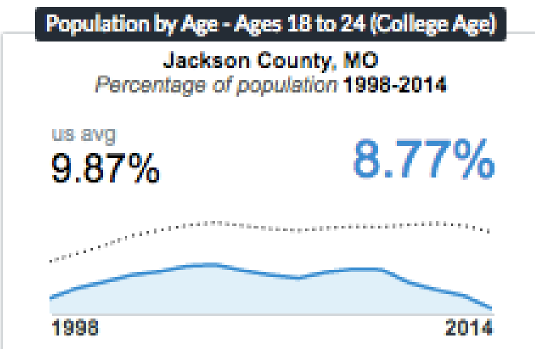
•**Total population** was 683,683, a growth rate of .27 percent.
•**Government employment in local services was 1,405,** ranking the county 3rd among peers.
•**Government employment in federal services was 1,207,** ranking the county 2rd among peers.
•**Average traded establishment size was 18,** higher than the U.S. average of 16, ranking the county 8th among peers.
•**Young adult population** was 188,653, a negative growth rate of -0.59 percent.
•**The percentage of the population ages 0-4 (preschool)** was 6.85 percent, higher than the U.S. average of 6.23 percent.
• **The percentage of the population ages 5-17 (school age)** was 17.21 percent, higher than the U.S. average of 16.85 percent**.**
•**The percentage of the population ages 18-24 (college age)** was 8.77 percent, lower than the U.S. average of 9.87 percent.
•**The percentage of the population ages 25-44 (young adult)** was 27.59 percent, higher than the U.S. average of 26.37 percent.
•**The percentage of the population ages 45-64 (older adult)** was 26.05 percent, slightly lower than the U.S. average of 26.20 percent.
•**The percentage of the population ages 65 and older (older adult)** was 13.53 percent, lower than the U.S. average of 14.49 percent.
•**Population density per square mile** was 1,118, higher than the U.S. average of 88**.**
•**Net international migration** was .18 percent of total population, lower than the national average of .31 percent.
•**Net domestic migration** was -.14 percent of total population.
•**Agriculture output as a percentage of GDP** was .10 percent, a growth rate of .80 percent.

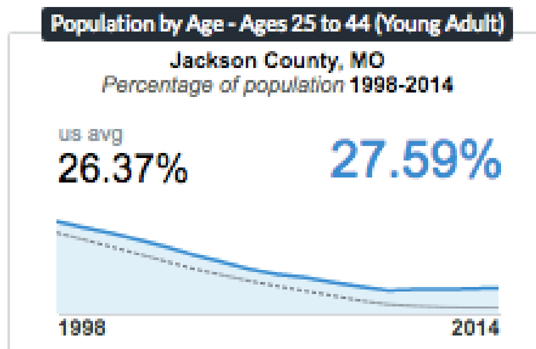
DEMOGRAPHICS
POPULATION TRENDS & GROWTH
Jackson County, Mo. and the State of Missouri

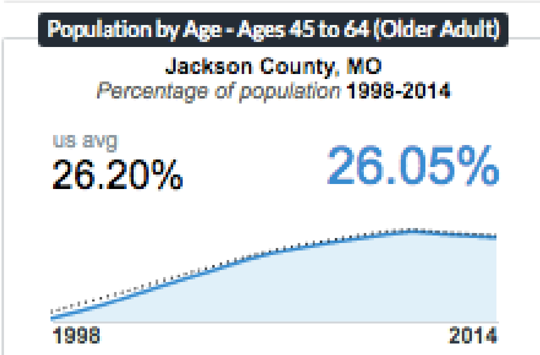
Population

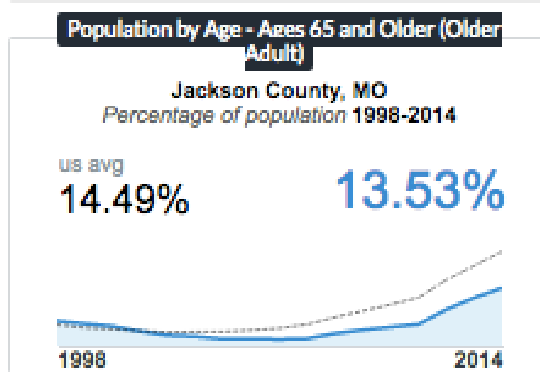


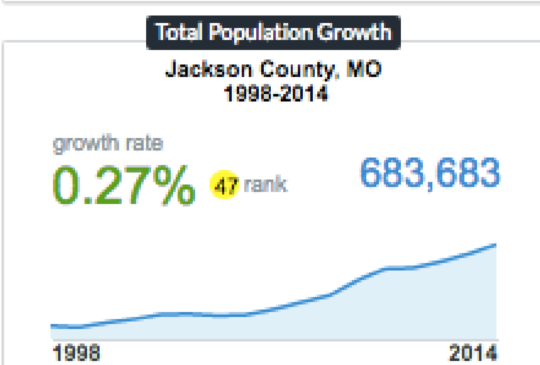


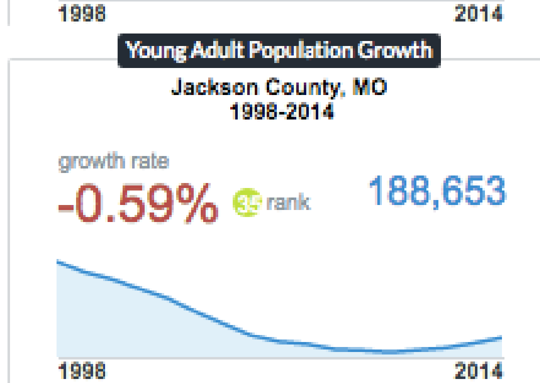




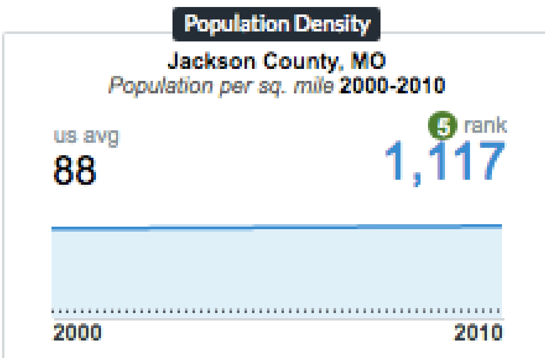


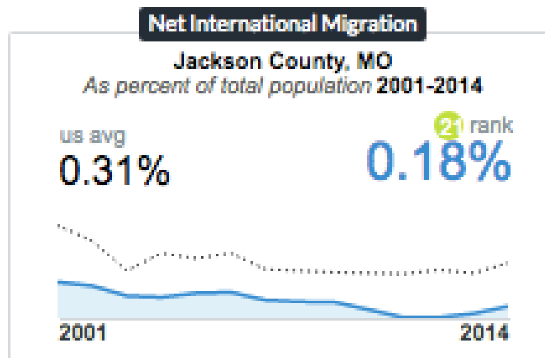


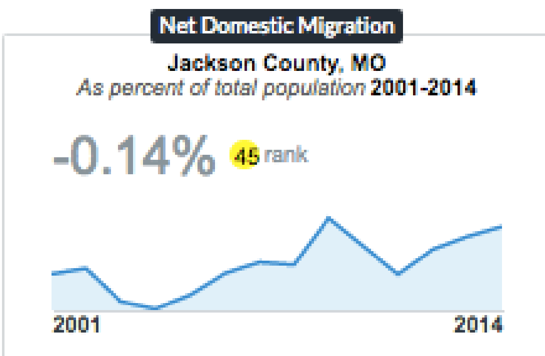


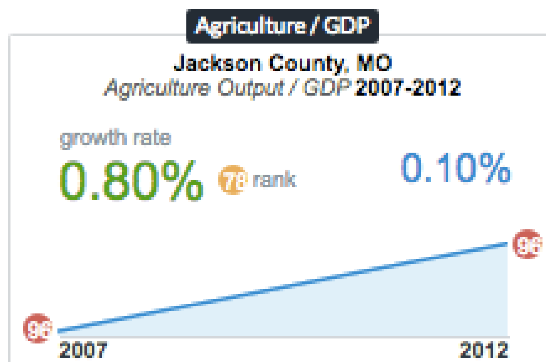


DEMOGRAPHICS
POPULATION DENSITY, MIGRATION, GDP
Jackson County, Mo. and the State of Missouri…







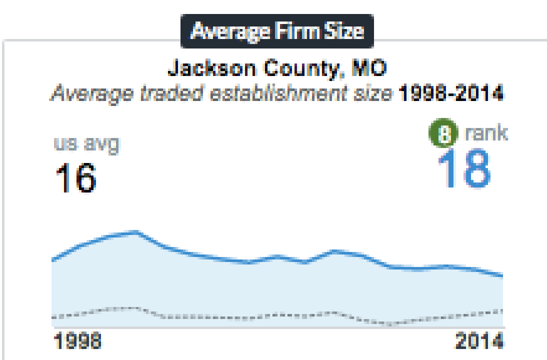


DEMOGRAPHICS
GOVERNMENT EMPLOYMENT & HEADQUARTERS

Jackson County, Mo. and the State of Missouri

•**Jackson County had 1,405 local government employees in 2013,** ranking 3rd.
•**Jackson County had 1,207 federal employees in 2013**, ranking 2nd**.**
•**Missouri government employment in higher education was 43,862.**
•**Missouri government employment in health and hospitals was 14,616.**
•**Jackson County's average firm size was 18,** ranking 8th
•**Missouri is the headquarters** home for 29 Fortune 1000 firms, ranking 24th.

Firm Demographics



Industry Clusters

CLUSTER ANALYSIS
JACKSON COUNTY EMPLOYMENT
(FIVE-YEAR TREND 2009-2014

Jackson County job growth was most significant in the transportation, manufacturing and service industries, with freight transportation arrangement jobs leading the way:

•Freight transportation arrangement jobs rose 371% from 247 to 1,164 employees.

•Railroad rolling stock manufacturing jobs rose 31% from 135 to 177 employees.

•Auto equipment rental and leasing jobs rose 28.9% from 329 to 424 employees.

•Specialty food stores jobs rose 22.6% from 434 to 532 employees.

•Gas station jobs rose 26.5% from 1,663 to 2,104 employees.

•Utility system construction jobs rose 27.3% from 487 to 620 employees.

•Cut and sew apparel manufacturing jobs rose 33.3% from 18 to 24 employees.

•Soap, cleaning compound, toilet manufacturing jobs rose 20.6% from 180 employees to 217 employees.

CLUSTER ANALYSIS
JACKSON COUNTY WAGE GROWTH
(FIVE-YEAR TREND 2009-2014)

Wage growth in Jackson County from 2009-2014 was most significant in the following sectors: Software publishing, sound recording, messenger and delivery services, freight transportation, railroad support manufacturing and residential construction.

•Software publishers: Average Annual Wage (AAW) rose 72% from $63,362 to $109,070.

•Sound recording industry: AAW rose 43% from $48,421 to $69,391.

•Local messengers and local delivery: AAW rose 42.3% from $26,470 to $37,657.

•Support activities for freight transportation: AAW rose 42.1% from $25,983 to $36,926.

•Freight transportation arrangement: AAW rose 33.6% from $48,795 to $65,211.

•Railroad rolling stock manufacturing: AAW rose 23.5% from $57,987 to $71,642.

•Residential building construction: AAW rose 23.2% from $36,037 to $44,412.

CLUSTER ANALYSIS
JACKSON COUNTY NUMBER OF ESTABLISHMENTS
(FIVE-YEAR TREND 2009-2014)

•Support activities for road transportation establishments rose 36% from 22 to 30.

•Facilities support services establishments rose 120% from 5 establishments to 11.

•Boiler, tank, shipping container manufacturing establishments rose 20% from 5 establishments to 6.

•Psychological and substance abuse hospital establishments rose 50% from 4 establishments to 6.

•Ground passenger transportation establishments rose 50% from 10 establishments to 15.

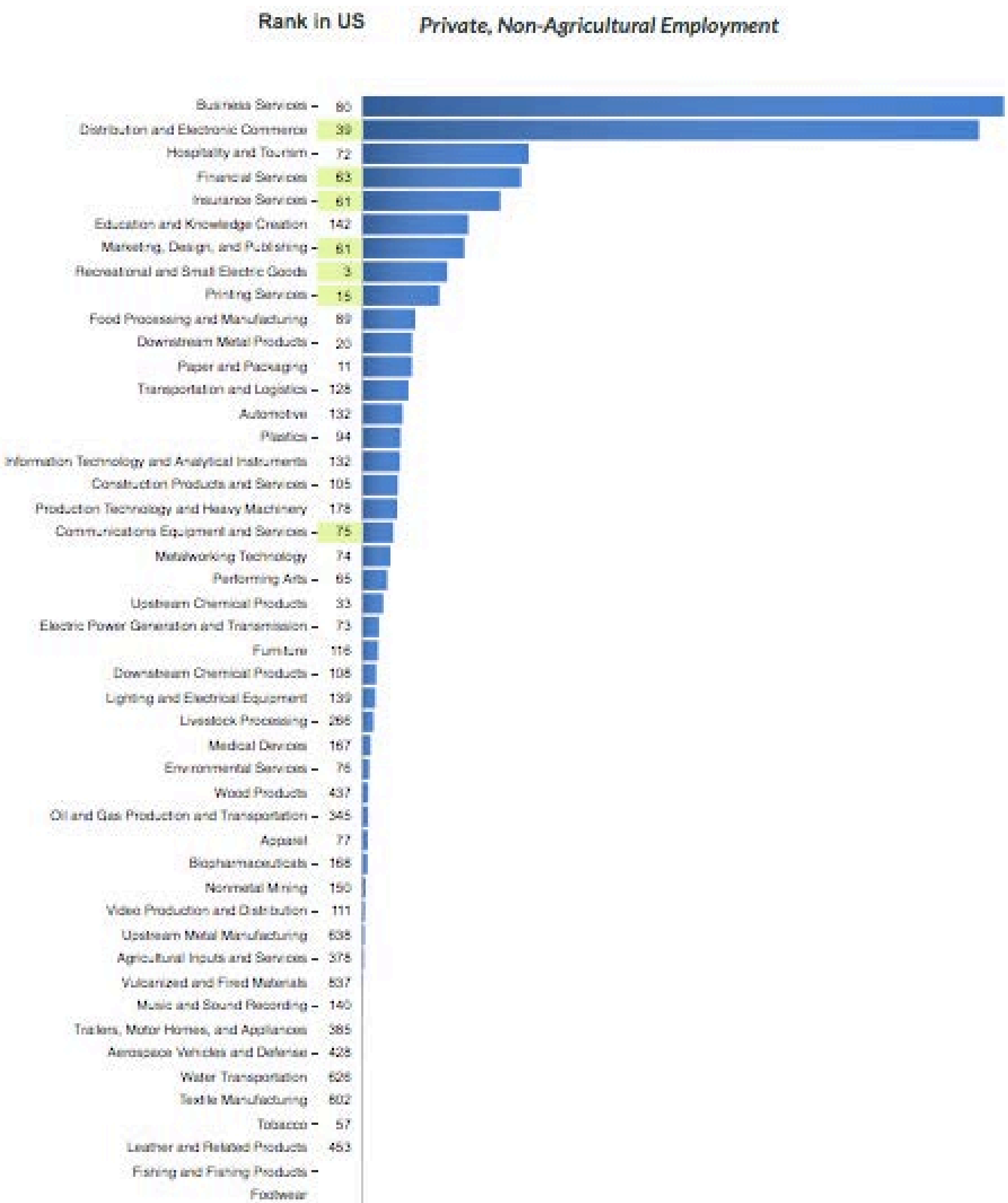
•Cut and sew apparel manufacturing establishments rose 33% from 3 establishments to 4.

CLUSTER ANALYSIS
JACKSON COUNTY DATA POINTS
(FIVE-YEAR TREND 2009-2014)

industry	industry_title	Est09	EMP09	AAW09	Est11	EMP11	AAW11	EST14	EMP14	AAW14	1 YR Δ	1 YR Δ	1 YR Δ	5 YR Δ	5 YR Δ	5 YR Δ
5112	Software publishers	22	152	63362	15	89	103547	16	166	109070	6.7%	86.5%	5.3%	-27.3%	9.2%	72.1%
4922	Local messengers and local delivery	14	169	26470	9	64	32074	12	113	37657	33.3%	76.6%	17.4%	-14.3%	-33.1%	42.3%
4885	Freight transportation arrangement	41	247	48795	32	709	62164	36	1164	65211	12.5%	64.2%	4.9%	-12.2%	371.3%	33.6%
1114	Greenhouse and nursery production	6	0	0	5	76	22817	6	122	26985	20.0%	60.5%	18.3%	0.0%		
4243	Apparel and piece goods merchant wholesalers	15	58	55088	12	30	35219	12	47	32667	0.0%	56.7%	-7.2%	-20.0%	-19.0%	-40.7%
5615	Travel arrangement and reservation services	37	0	0	30	75	39993	26	103	44116	-13.3%	37.3%	10.3%	-29.7%		
4452	Specialty food stores	44	434	29753	41	428	24226	42	532	30062	2.4%	24.3%	24.1%	-4.5%	22.6%	1.0%
1121	Cattle ranching and farming	6	0	0	5	17	182064	5	21	156662	0.0%	23.5%	-14.0%	-16.7%		
2372	Land subdivision	21	64	42082	10	27	32427	9	33	45466	-10.0%	22.2%	40.2%	-57.1%	-48.4%	8.0%
4884	Support activities for road transportation	22	224	25983	26	160	39052	30	195	36926	15.4%	21.9%	-5.4%	36.4%	-12.9%	42.1%
5321	Automotive equipment rental and leasing	39	329	30956	44	348	32042	43	424	30642	-2.3%	21.8%	-4.4%	10.3%	28.9%	-1.0%
5612	Facilities support services	5	0	0	9	133	30421	11	162	35387	22.2%	21.8%	16.3%	120.0%		
3328	Coating, engraving, and heat treating metals	30	378	33279	28	372	35785	27	449	40423	-3.6%	20.7%	13.0%	-10.0%	18.8%	21.5%
4471	Gasoline stations	200	1663	22384	214	1781	23665	222	2104	21894	3.7%	18.1%	-7.5%	11.0%	26.5%	-2.2%
2371	Utility system construction	44	487	47794	36	526	58895	41	620	55208	13.9%	17.9%	-6.3%	-6.8%	27.3%	15.5%
5614	Business support services	127	1548	34684	116	1443	37484	118	1694	36335	1.7%	17.4%	-3.1%	-7.1%	9.4%	4.8%
2361	Residential building construction	329	892	36037	254	828	42023	269	960	44412	5.9%	15.9%	5.7%	-18.2%	7.6%	23.2%
3256	Soap, cleaning compound, and toiletry mfg.	13	180	37647	10	191	34917	9	217	30033	-10.0%	13.6%	-14.0%	-30.8%	20.6%	-20.2%
3324	Boiler, tank, and shipping container mfg.	5	210	64358	5	143	54942	6	162	51143	20.0%	13.3%	-6.9%	20.0%	-22.9%	-20.5%
4541	Electronic shopping and mail-order houses	41	322	39932	46	310	41038	41	351	41371	-10.9%	13.2%	0.8%	0.0%	9.0%	3.6%
2373	Highway, street, and bridge construction	18	964	68617	13	854	72737	15	965	72397	15.4%	13.0%	-0.5%	-16.7%	0.1%	5.5%
2389	Other specialty trade contractors	156	1313	47361	130	1043	43487	133	1169	47239	2.3%	12.1%	8.6%	-14.7%	-11.0%	-0.3%
2383	Building finishing contractors	340	2069	43237	254	1618	41953	250	1808	43564	-1.6%	11.7%	3.8%	-26.5%	-12.6%	0.8%
3371	Household and institutional furniture mfg.	35	579	34669	27	564	37153	26	629	39003	-3.7%	11.5%	5.0%	-25.7%	8.6%	12.5%
5122	Sound recording industries	6	12	48421	4	9	64255	4	10	69391	0.0%	11.1%	8.0%	-33.3%	-16.7%	43.3%
8129	Other personal services	75	879	18211	75	929	19114	82	1032	18699	9.3%	11.1%	-2.2%	9.3%	17.4%	2.7%
6222	Psychiatric and substance abuse hospitals	4	0	0	5	829	41401	6	918	41584	20.0%	10.7%	0.4%	50.0%		
5418	Advertising, pr, and related services	171	1898	64612	157	1646	66833	157	1820	73875	0.0%	10.6%	10.5%	-8.2%	-4.1%	14.3%
8114	Household goods repair and maintenance	43	142	29466	39	91	26225	42	100	26184	7.7%	9.9%	-0.2%	-2.3%	-29.6%	-11.1%
3315	Foundries	7	0	0	7	136	45380	8	149	53261	14.3%	9.6%	17.4%	14.3%		
5622	Waste treatment and disposal	6	71	43547	5	43	51700	5	47	52088	0.0%	9.3%	0.8%	-16.7%	-33.8%	19.6%
7121	Museums, historical sites, zoos, and parks	8	789	31512	10	796	29467	9	869	29302	-10.0%	9.2%	-0.6%	12.5%	16.0%	-7.0%
5417	Scientific research and development services	23	1372	66225	27	1385	74654	25	1512	75113	-7.4%	9.2%	0.6%	8.7%	10.2%	13.4%
3152	Cut and sew apparel manufacturing	3	18	17384	6	22	20283	4	24	20450	-33.3%	9.1%	0.8%	33.3%	33.3%	17.6%
4859	Other ground passenger transportation	10	417	24361	16	474	25924	15	516	27141	-6.3%	8.9%	4.7%	50.0%	23.7%	11.4%
8141	Private households	906	946	14046	232	305	21632	262	332	22272	12.9%	8.9%	3.0%	-71.1%	-64.9%	58.6%
3365	Railroad rolling stock manufacturing	3	135	57987	4	163	79028	4	177	71642	0.0%	8.6%	-9.3%	33.3%	31.1%	23.5%

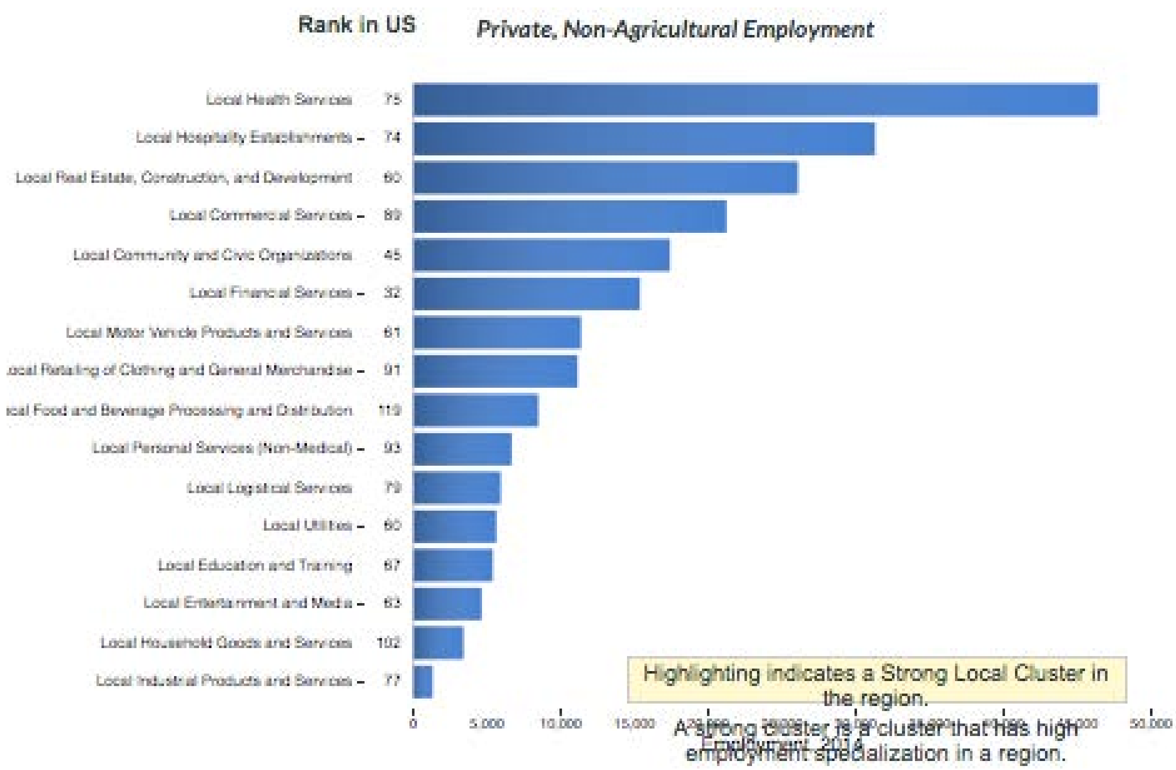
CLUSTER PORTFOLIO
Jackson County 2014 Employment by Traded Cluster

The charts below rank the leading clusters in the Jackson County region based on a set of core performance indicators. Traded clusters serve markets in other regions or nations, and are concentrated in regions that afford specific competitive advantages. Local clusters sell products and services primarily for the local market and are located in every region. (Rank numbers are out of 3,221 U.S counties.)



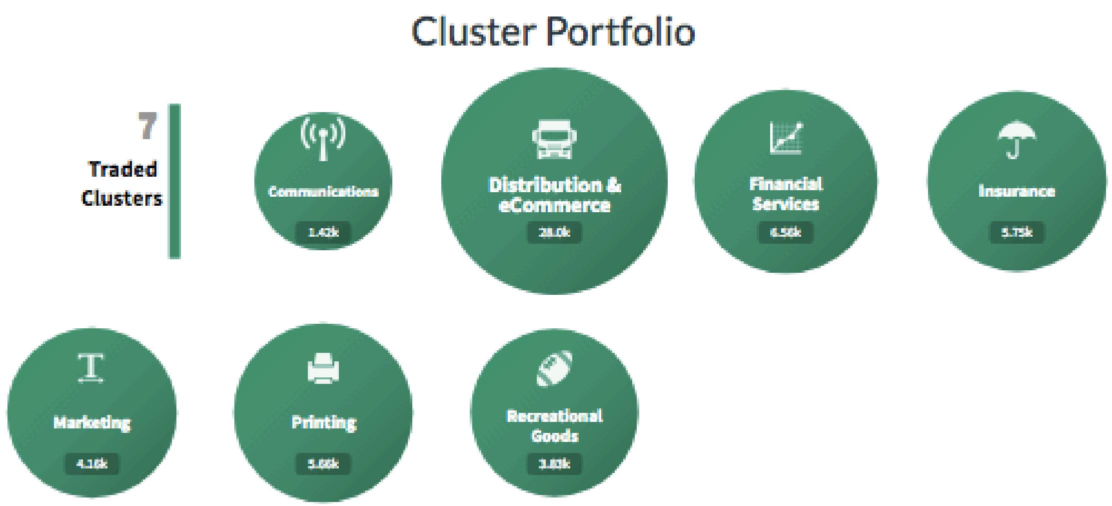
CLUSTER PORTFOLIO
Jackson County 2014 Employment by Local Cluster

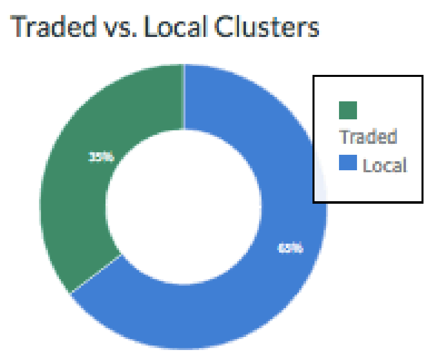
The charts below rank the leading clusters in the Jackson County region based on a set of core performance indicators. Traded clusters serve markets in other regions or nations, and are concentrated in regions that afford specific competitive advantages. Local clusters sell products and services primarily for the local market and are located in every region. (Rank numbers are out of 3,221 U.S counties.)

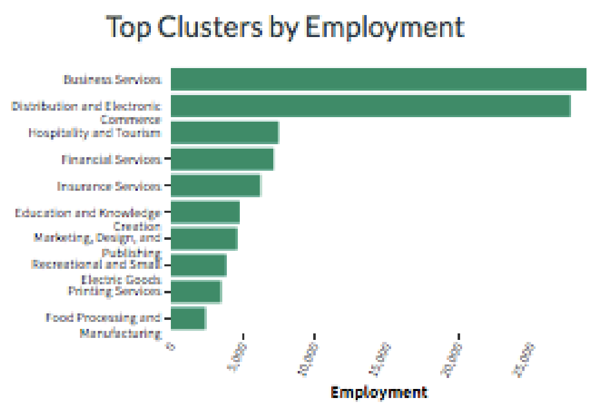


CLUSTER PORTFOLIO
Jackson County Traded vs. Local Clusters

Traded clusters serve markets in other regions or nations, and are concentrated in regions that afford specific competitive advantages. Local clusters sell products and services primarily for the local market and are located in every region.





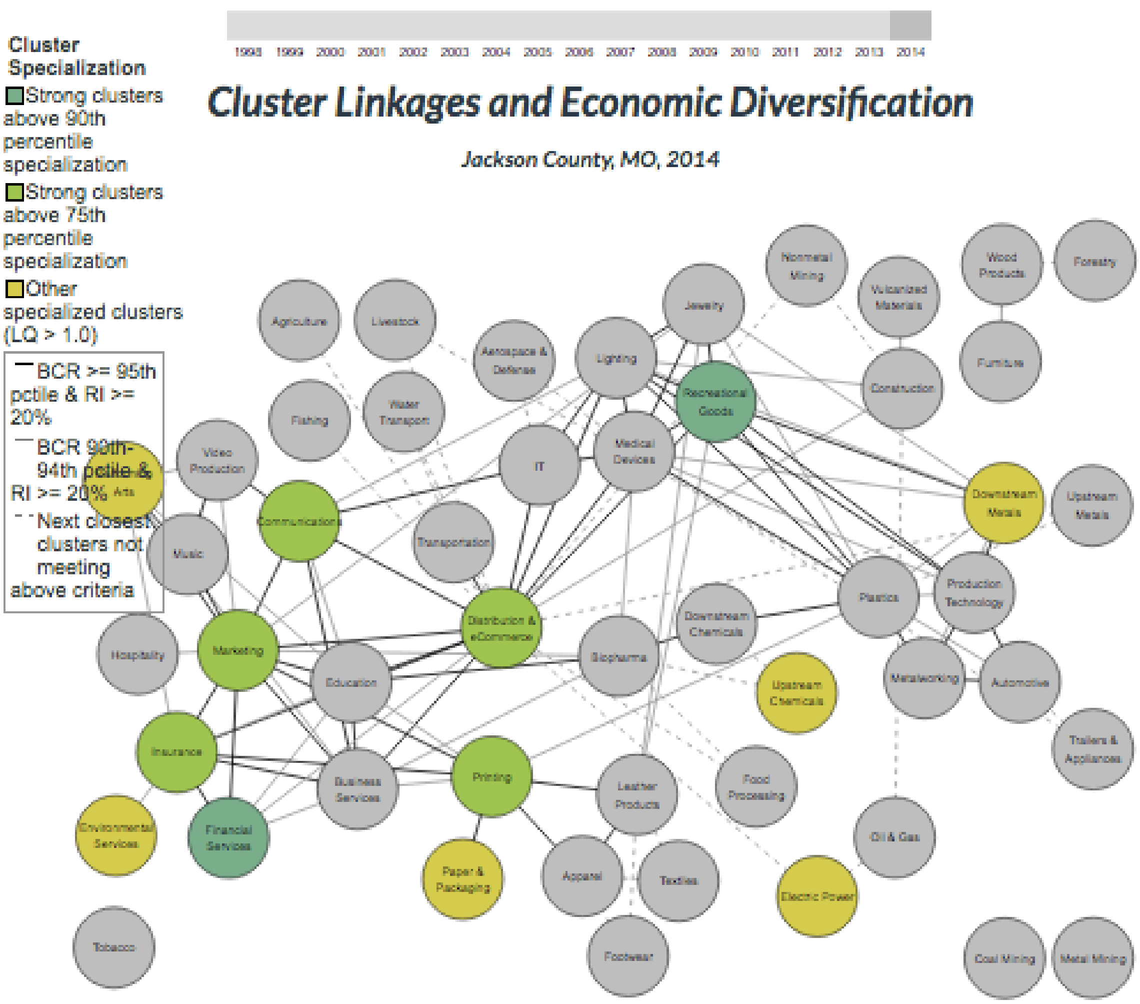


CLUSTER PORTFOLIO
Jackson County Cluster Linkages/Economic Diversification

Related Clusters

The data visualization below displays the related clusters with information about the specialization for this region.

More information on Related Clusters available here.



Lee's Summit Tapestry

LEE'S SUMMIT TAPESTRY
LIFEMODE GROUPS: FAMILY LANDSCAPES, AFFLUENT ESTATES, MIDDLE GROUND & GENXURBAN

According to market research into Lee's Summit families and residents, four general LIFEMODE groups emerged, with the strongest representation in the Family Landscapes and Affluent Estates LIFEMODE groups, followed by Middle Ground and GenXUrban LIFEMODE groups. Descriptions of each group are below.

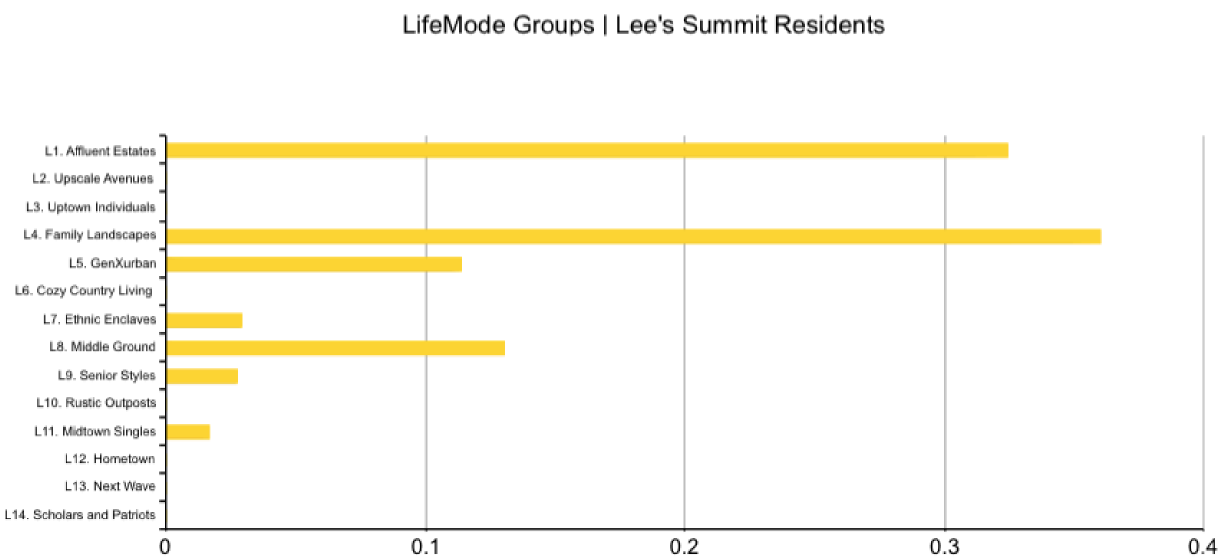
LifeMode 4 Family Landscapes
•Successful young families in their first homes
•Non-diverse, prosperous married-couple families, residing in suburban or semirural areas with a low vacancy rate (second lowest)
•Homeowners (80%) with mortgages (second highest %), living in newer single-family homes, with median home value slightly higher than the U.S.
•Two workers in the family, contributing to the second highest labor force participation rate, as well as low unemployment
•Do-it-yourselfers, who work on home improvement projects, as well as their lawns and gardens
•Sports enthusiasts, typically owning newer sedans or SUVs, dogs, and savings accounts/plans, comfortable with the latest technology
•Eat out frequently at fast food or family restaurants to accommodate their busy lifestyle
•Especially enjoy bowling, swimming, playing golf, playing video games, watching movies rented via Redbox, and taking trips to a zoo or theme park

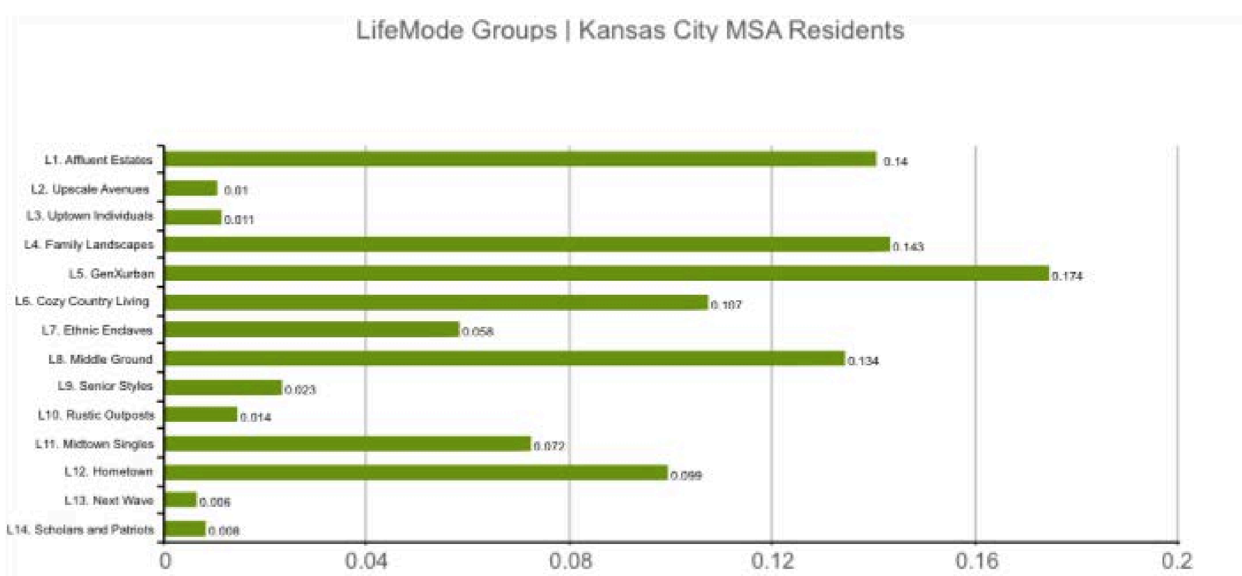
LifeMode 1 Affluent Estates
•Established wealth—educated, well-traveled married couples
•Accustomed to "more": less than 10% of all households, with 20% of household income
•Homeowners (almost 90%), with mortgages (70%)
•Married couple families with children ranging from grade school to college
•Expect quality; invest in time-saving services
•Participate actively in their communities
•Active in sports and enthusiastic travelers

LifeMode 8 Middle Ground
•Lifestyles of thirtysomethings
•Millennials in the middle: single/married, renters/homeowners, middle class/working class
•Urban market mix of single-family, townhome, and multi-unit dwellings
•Majority of residents attended college or attained a college degree
•Householders have ditched their landlines for cell phones, which they use to listen to music (generally contemporary hits), read the news, and get the latest sports updates of their favorite teams
•Online all the time: use the Internet for entertainment (downloading music, watching YouTube, finding dates), social media (Facebook, Twitter, LinkedIn), shopping and news
•Leisure includes night life (clubbing, movies), going to the beach, some travel and hiking

LifeMode 5 GenXurban
•Gen X in middle age; families with fewer kids and a mortgage
•Second largest Tapestry group, comprised of Gen X married couples, and a growing population of retirees
•About a fifth of residents are 65 or older; about a fourth of households have retirement income
•Own older single-family homes in urban areas, with 1 or 2 vehicles
•Live and work in the same county, creating shorter commute times
•Invest wisely, well-insured, comfortable banking online or in person
•News junkies (read a daily newspaper, watch news on TV, and go online for news)
•Enjoy reading, photo album/scrapbooking, playing board games and cards, doing crossword puzzles, going to museums and rock concerts, dining out, and walking for exercise

LEE'S SUMMIT TAPESTRY
LIFEMODE GROUPS: FAMILY LANDSCAPES, AFFLUENT ESTATES, MIDDLE GROUND & GENXURBAN





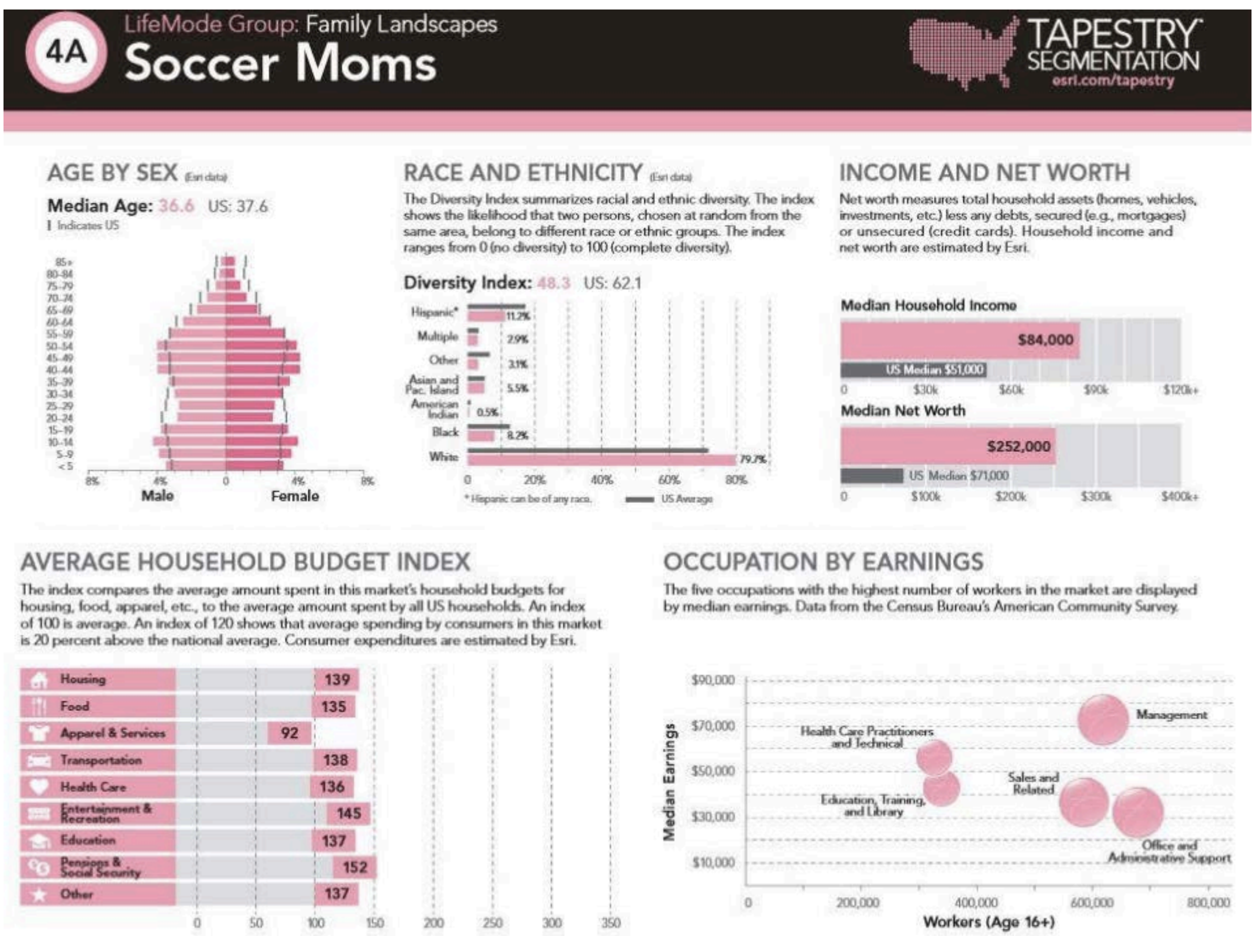
NORTH STAR DESTINATION STRATEGIES

COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #1: SOCCER MOMS

The rise of the dual income, community-minded family is a demographic trend that's taken hold in Lee's Summit over the past five years. That insight is among several key demographic trends identified by North Star Destination Strategies and presented to EDC and City leaders in 2015.

The information will inform the City's economic development efforts by offering valuable insight into key demographic trends, North Star's research will now enable the EDC and City to target specific industries for expansion and new business attraction. A description of the Soccer Moms Tapestry Segmentation is below.



LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #1: SOCCER MOMS

LifeMode Group: Family Landscapes

Soccer Moms

4A

Households: 3,327,000

Average Household Size: 2.96

Median Age: 36.6

Median Household Income: $84,000

WHO ARE WE?

Soccer Moms is an affluent, family-oriented market with a country flavor. Residents are partial to new housing away from the bustle of the city but close enough to commute to professional job centers. Life in this suburban wilderness offsets the hectic pace of two working parents with growing children. They favor time-saving devices, like banking online or housekeeping services, and family-oriented pursuits.

OUR NEIGHBORHOOD

- *Soccer Moms* residents prefer the suburban periphery of metropolitan areas.
- Predominantly single family, homes are in newer neighborhoods, 36% built in the 1990s (Index 253), 31% built since 2000.
- Owner-occupied homes have high rate of mortgages at 74% (Index 163), and low rate vacancy at 5%.
- Median home value is $226,000.
- Most households are married couples with children; average household size is 2.96.
- Most households have 2 or 3 vehicles; long travel time to work including a disproportionate number commuting from a different county (Index 133).

SOCIOECONOMIC TRAITS

- Education: 37.7% college graduates; more than 70% with some college education.
- Low unemployment at 5.9%; high labor force participation rate at 72%; 2 out of 3 households include 2+ workers (Index 124).
- Connected, with a host of wireless devices from iPods to tablets—anything that enables convenience, like banking, paying bills, or even shopping online.
- Well insured and invested in a range of funds, from savings accounts or bonds to stocks.
- Carry a higher level of debt, including first (Index 159) and second mortgages (Index 154) and auto loans (Index 151).

TAPESTRY SEGMENTATION
esri.com/tapestry

Note: The Index represents the ratio of the segment rate to the US rate multiplied by 100. Consumer preferences are estimated from data by GfK MRI.

4A LifeMode Group: Family Landscapes

Soccer Moms

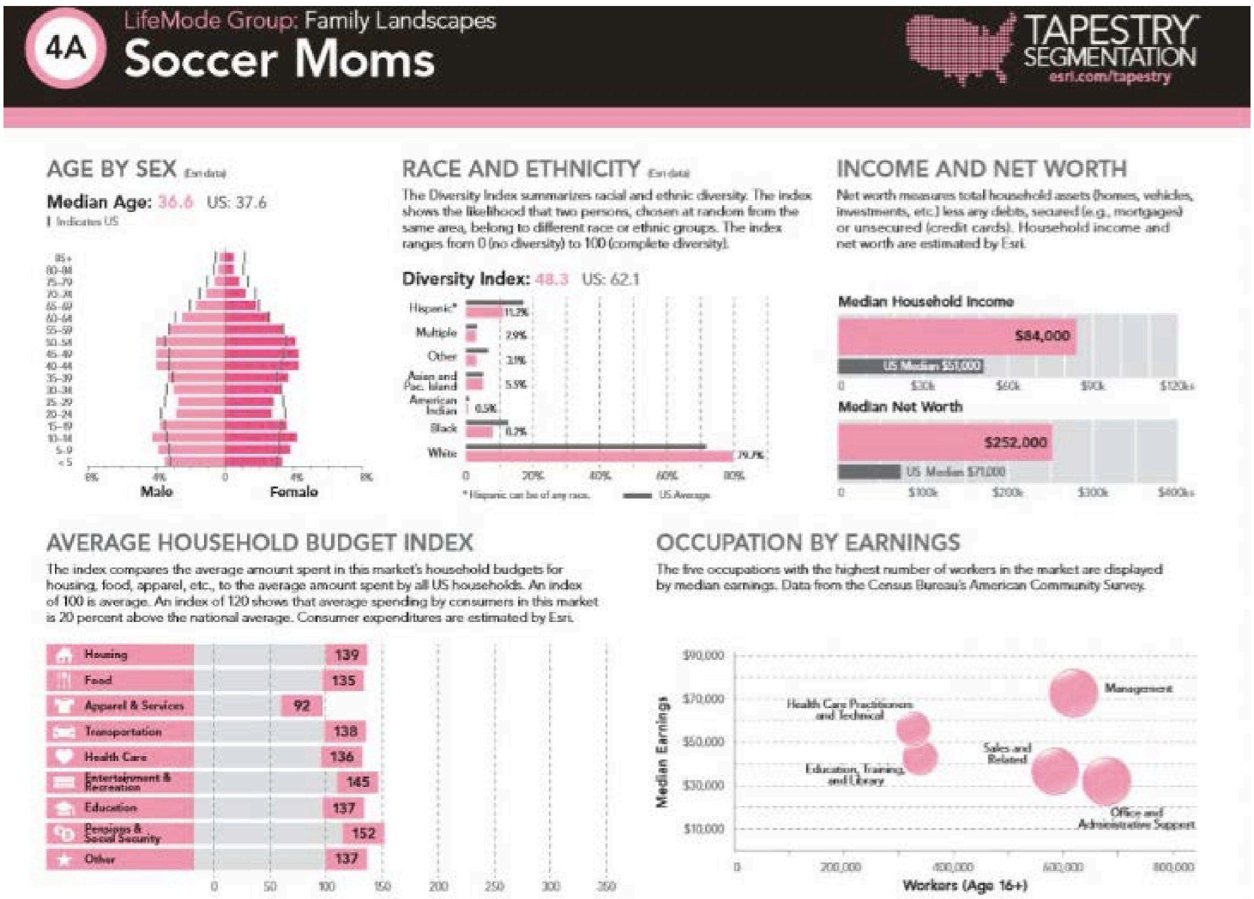
TAPESTRY SEGMENTATION
esri.com/tapestry

NORTH STAR DESTINATION STRATEGIES

COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

LEE’S SUMMIT TAPESTRY

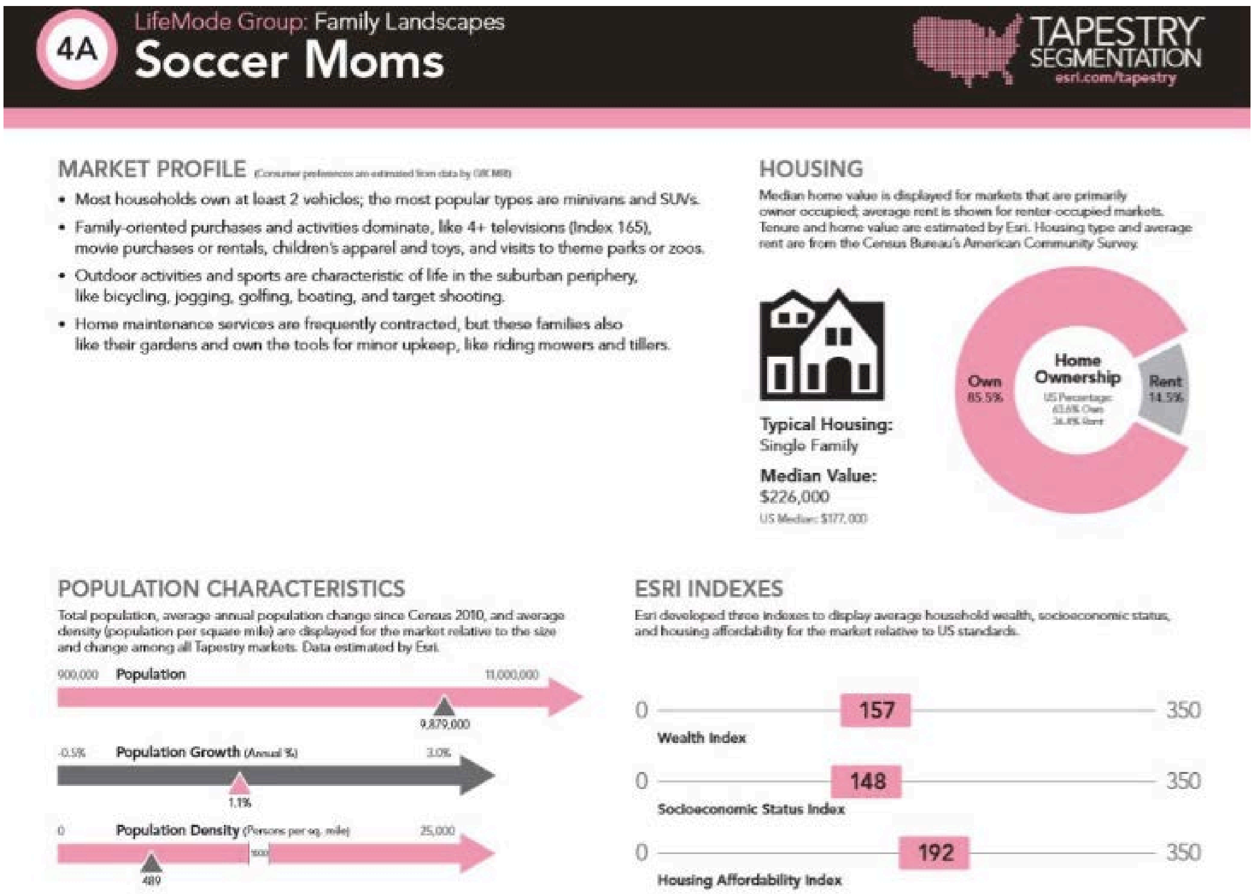
TAPESTRY SEGMENTATION #1: SOCCER MOMS



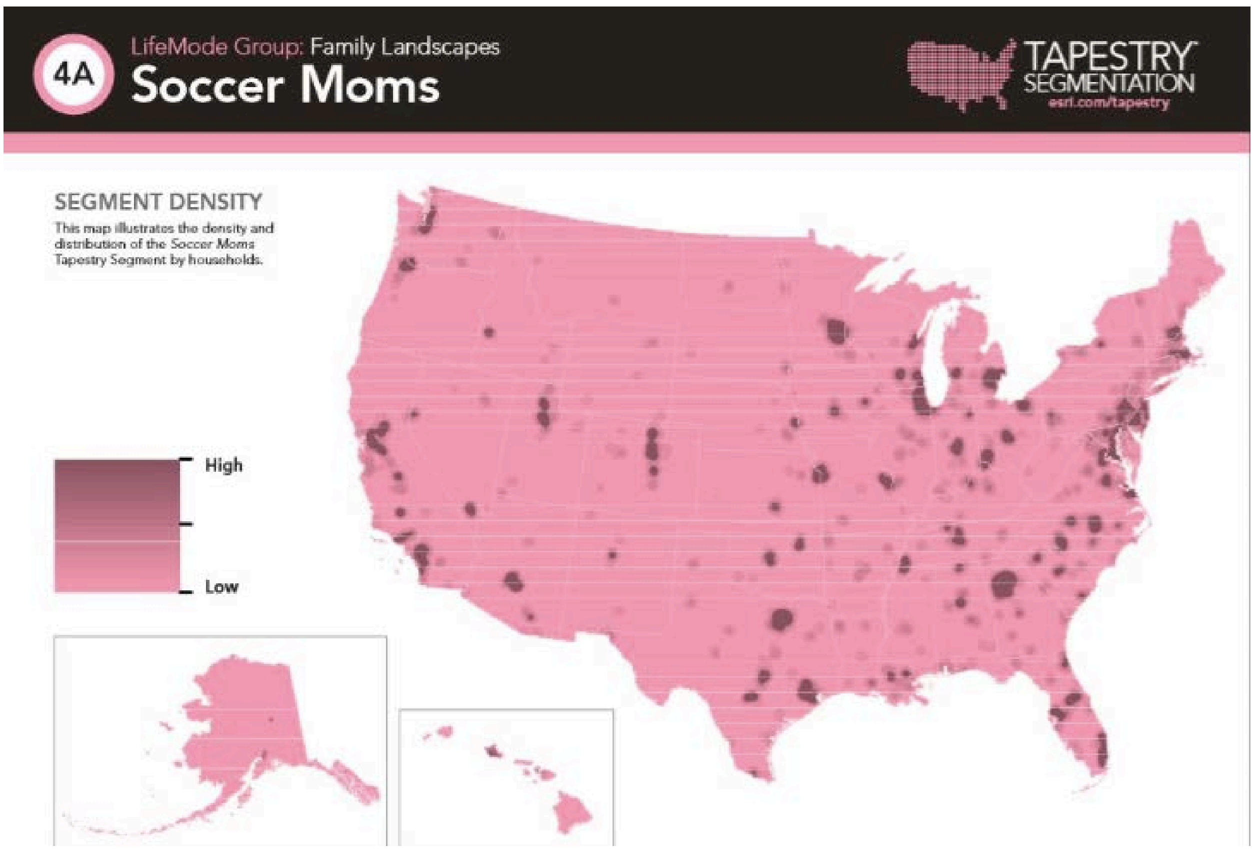
NORTH STAR DESTINATION STRATEGIES

COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

LEE’S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #1: SOCCER MOMS

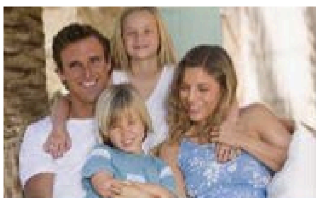


LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #1: SOCCER MOMS



LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #2: PROFESSIONAL PRIDE

In recent years, the Lee's Summit community has grown in the number of households characterized by Professional Pride. These consumers are well-educated professionals that have prospered throughout the Great Recession. Details about the Professional Pride Tapestry Segmentation are below.



LifeMode Group: Affluent Estates

Professional Pride

1B

Households: 1,878,000

Average Household Size: 3.11

Median Age: 40.5

Median Household Income: $127,000

WHO ARE WE?

Professional Pride consumers are well-educated career professionals that have prospered through the Great Recession. To maintain their upscale suburban lifestyles, these goal oriented couples work, often commuting far and working long hours. However, their schedules are fine-tuned to meet the needs of their school age children. They are financially savvy; they invest wisely and benefit from interest and dividend income. So far, these established families have accumulated an average of 1.5 million dollars in net worth, and their annual household income runs at more than twice the US level. They take pride in their newer homes and spend valuable time and energy upgrading. Their homes are furnished with the latest in home trends, including finished basements equipped with home gyms and in-home theaters.

TAPESTRY SEGMENTATION
esri.com/tapestry

OUR NEIGHBORHOOD

- Typically owner occupied (Index 173), single-family homes are in newer neighbor hoods: 59% of units were built in the last 20 years.
- Neighborhoods are primarily located in the suburban periphery of large metropolitan areas.
- Most households own two or three vehicles; long commutes are the norm.
- Homes are valued at more than twice the US median home value, although three out of four homeowners have mortgages to pay off.
- Families are mostly married couples (almost 80% of households), and more than half of these families have kids. Their average household size, 3.11, reflects the presence of children.

SOCIOECONOMIC TRAITS

- *Professional Pride* consumers are highly qualified in the science, technology, law, or finance fields; they've worked hard to build their professional reputation or their start-up businesses.
- These consumers are willing to risk their accumulated wealth in the stock market.
- They have a preferred financial institution, regularly read financial news, and use the Internet for banking transactions.
- These residents are goal oriented and strive for lifelong earning and learning.
- Life here is well organized; routine is a key ingredient to daily life.

Note: The Index represents the ratio of the segment rate to the US rate multiplied by 100. Consumer preferences are estimated from data by GfK MRI.

1B LifeMode Group: Affluent Estates
Professional Pride

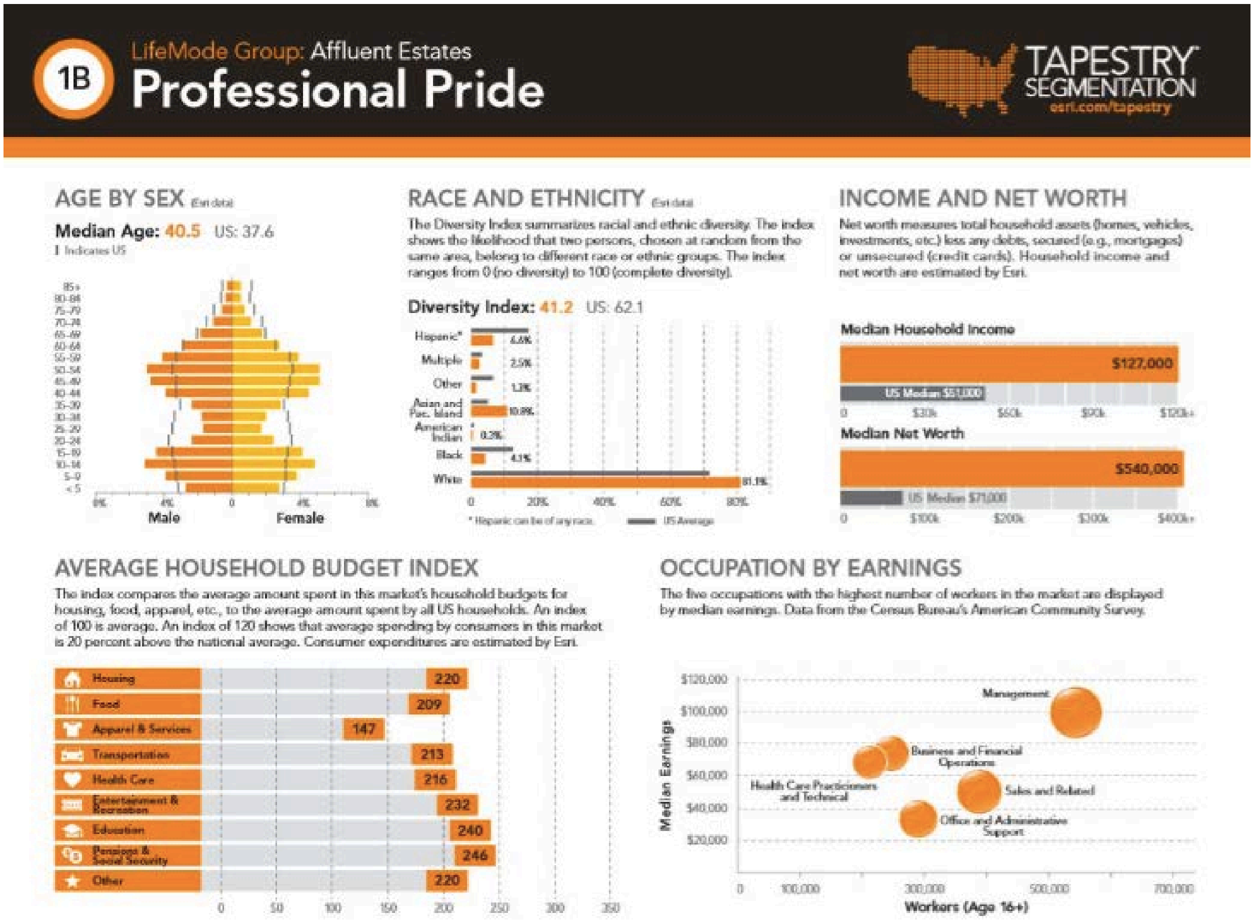
TAPESTRY SEGMENTATION
esri.com/tapestry

NORTH STAR DESTINATION STRATEGIES

COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

LEE'S SUMMIT TAPESTRY

TAPESTRY SEGMENTATION #2: PROFESSIONAL PRIDE

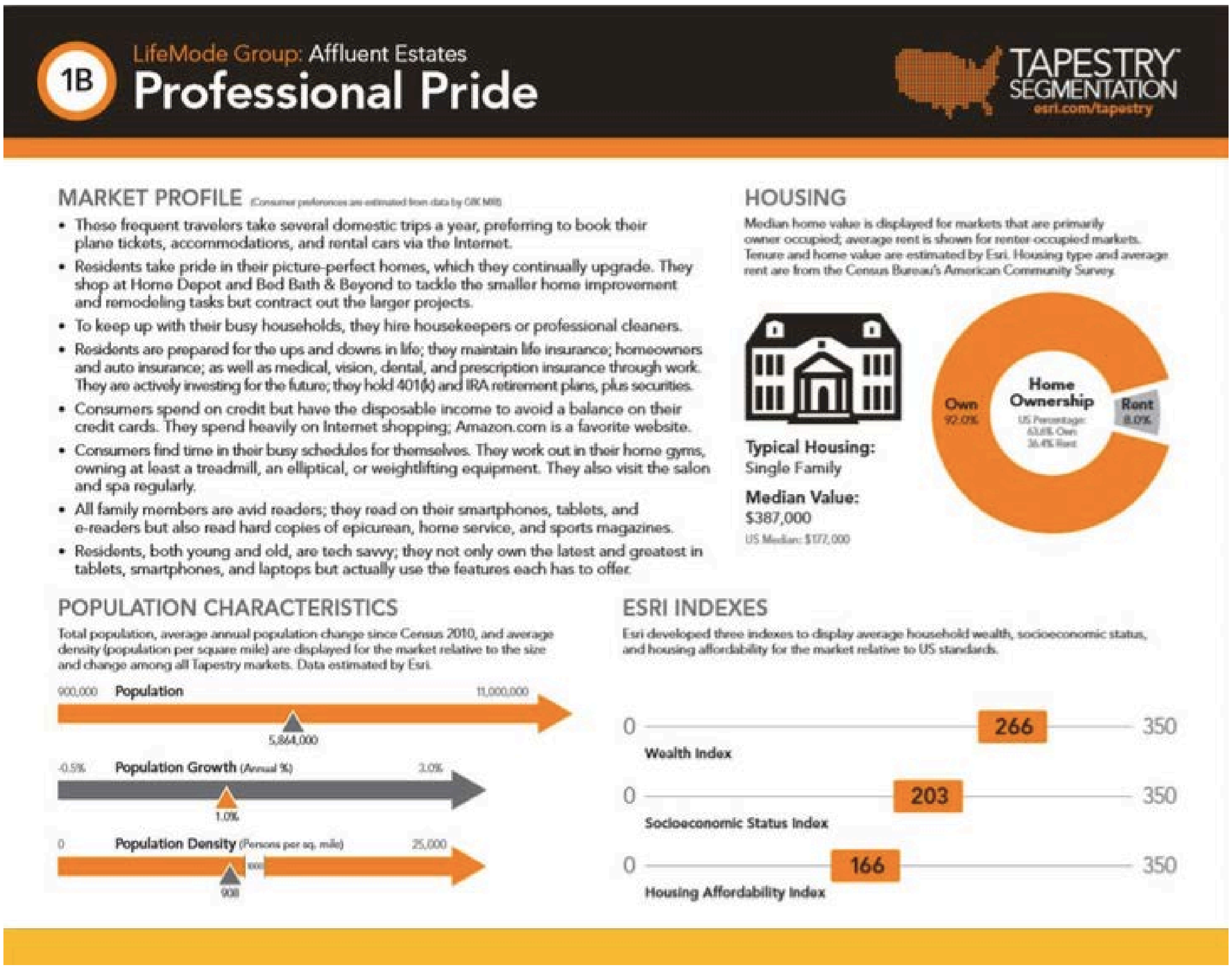


NORTH STAR DESTINATION STRATEGIES

COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

LEE'S SUMMIT TAPESTRY

TAPESTRY SEGMENTATION #2: PROFESSIONAL PRIDE



LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #2: PROFESSIONAL PRIDE

LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #3 : HOME IMPROVEMENT

Lee's Summit has seen an increasing number of Home Improvement households. These are generally married couple families with single-family homes that are owner-occupied. Details and a description of the Home Improvement Tapestry Segmentation are below.

LifeMode Group: Family Landscapes

Home Improvement

4B

Households: 2,058,000

Average Household Size: 2.86

Median Age: 37.0

Median Household Income: $67,000

WHO ARE WE?

Married-couple families occupy well over half of these suburban households. Most *Home Improvement* residences are single-family homes that are owner occupied, with only one-fifth of the households occupied by renters. Education and diversity levels are similar to the US as a whole. These families spend a lot of time on the go and therefore tend to eat out regularly. When at home, weekends are consumed with home improvement and remodeling projects.

OUR NEIGHBORHOOD

- These are low density suburban neighborhoods.
- Eight of every 10 homes are traditional single-family dwellings, owner occupied.
- Majority of the homes were built between 1970 and 2000.
- More than half of the households consist of married-couple families; another 12% include single-parent families.

SOCIOECONOMIC TRAITS

- Higher participation in the labor force and lower unemployment than US levels; most households have 2+ workers.
- Cautious consumers that do their research before buying, they protect their investments.
- Typically spend 4–7 hours per week commuting, and, therefore, spend significant amounts on car maintenance (performed at a department store or auto repair chain store).
- They are paying off student loans and second mortgages on homes.
- They spend heavily on eating out, at both fast-food and family restaurants.
- They like to work from home, when possible.

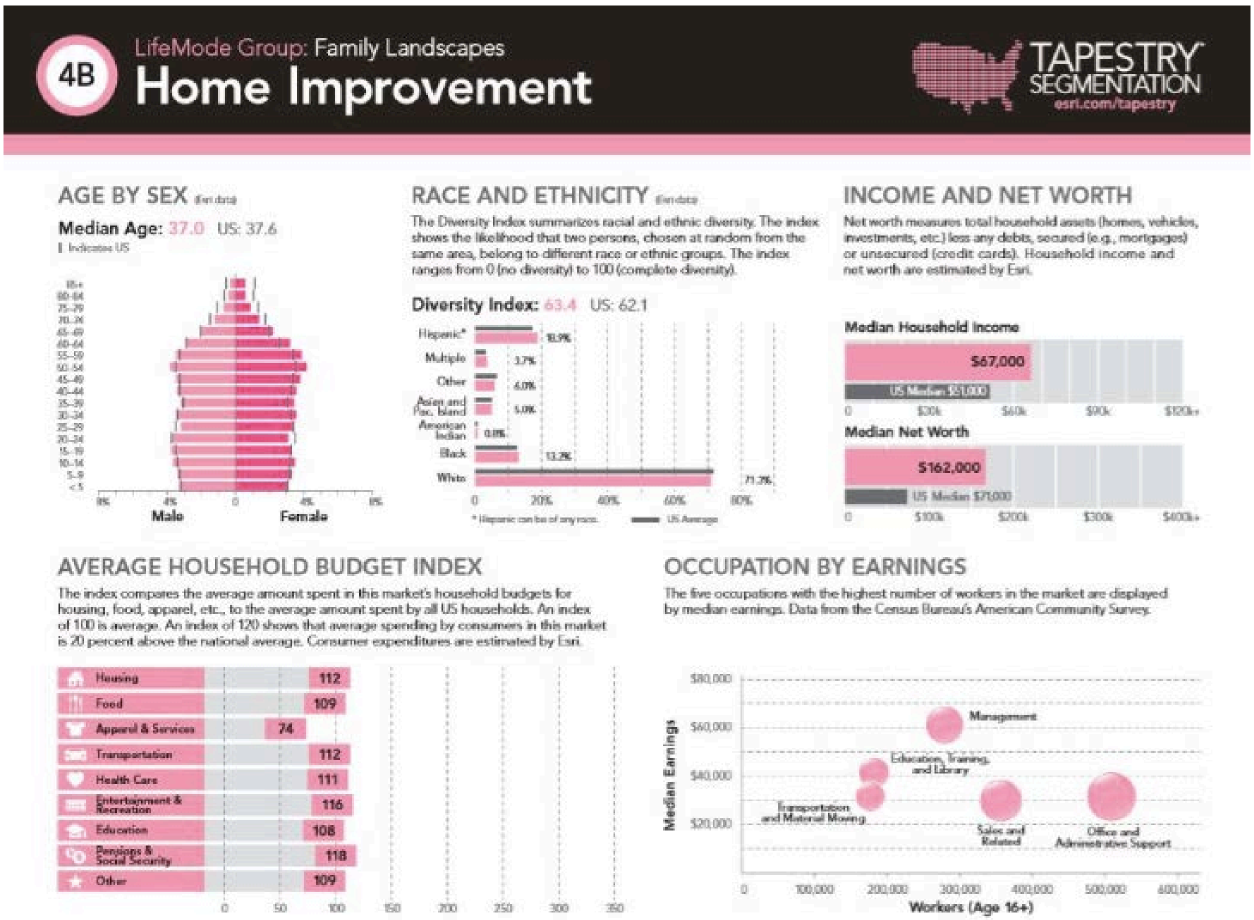
TAPESTRY™ SEGMENTATION
esri.com/tapestry

NORTH STAR DESTINATION STRATEGIES

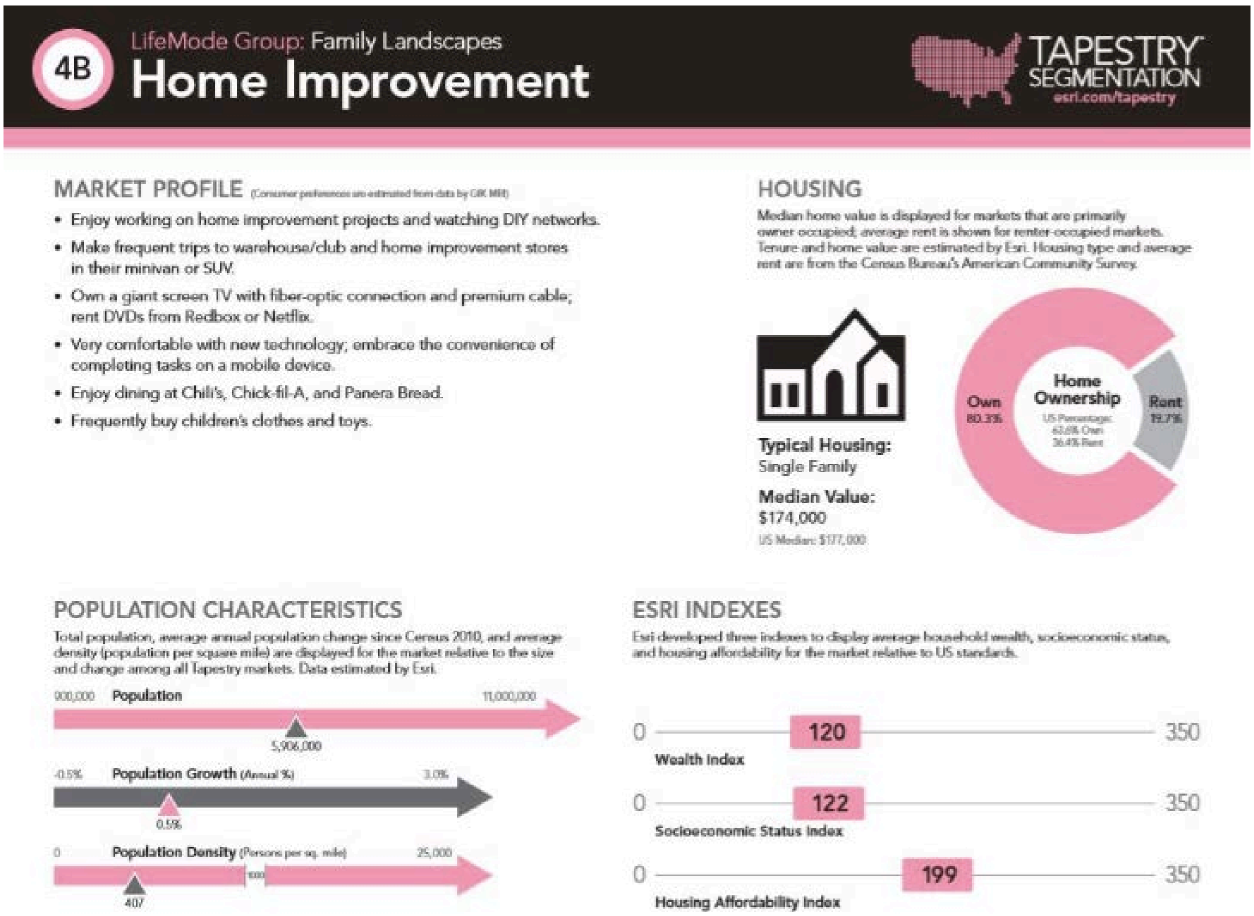
COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

LEE'S SUMMIT TAPESTRY

TAPESTRY SEGMENTATION #3 : HOME IMPROVEMENT



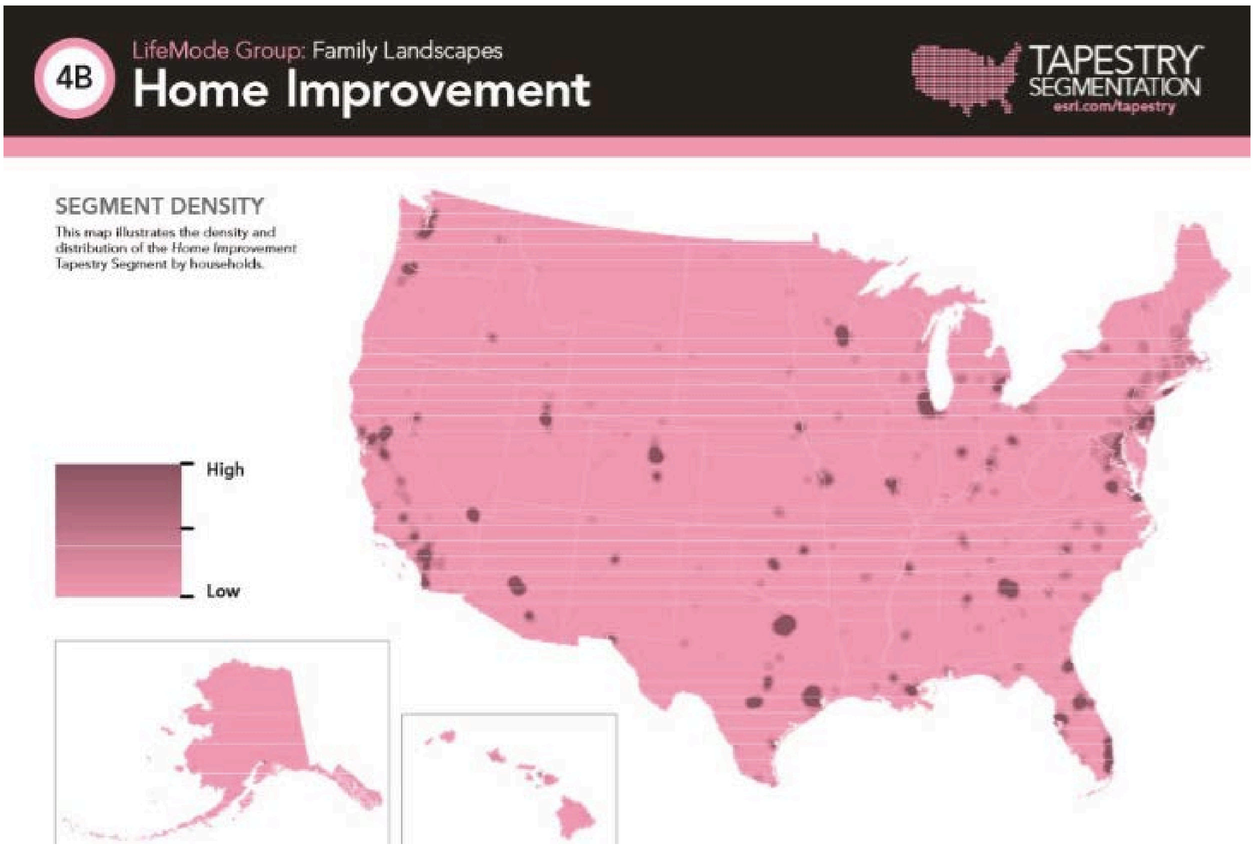
LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #3 : HOME IMPROVEMENT



NORTH STAR DESTINATION STRATEGIES

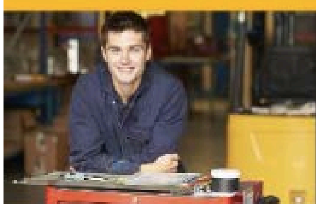
COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #3 : HOME IMPROVEMENT



LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #4 : OLD & NEWCOMERS

Another growing tapestry segmentation in Lee's Summit is the Old & Newcomers, characterized by a singles lifestyle that is budget conscious. Details and a description of the Old & Newcomer Tapestry Segmentation are below.



LifeMode Group: Middle Ground

Old and Newcomers

8F

Households: 2,774,000

Average Household Size: 2.11

Median Age: 38.5

Median Household Income: $39,000

WHO ARE WE?

This market features singles' lifestyles, on a budget. The focus is more on convenience than consumerism, economy over acquisition. *Old and Newcomers* is composed of neighborhoods in transition, populated by renters who are just beginning their careers or retiring. Some are still in college; some are taking adult education classes. They support environmental causes and Starbucks. Age is not always obvious from their choices.

OUR NEIGHBORHOOD

- Metropolitan city dwellers.
- Predominantly single households (Index 148), with a mix of married couples (no children); average household size lower at 2.11.
- 54% renter occupied; average rent, $800 (Index 88).
- 45% of housing units are single-family dwellings; 44% are multiunit buildings in older neighborhoods, built before 1980.
- Average vacancy rate at 11%.

SOCIOECONOMIC TRAITS

- Unemployment is lower at 7.8% (Index 91), with an average labor force participation rate of 62.6%, despite the increasing number of retired workers.
- 30% of households are currently receiving Social Security.
- 28% have a college degree (Index 99), 33% have some college education, 10% are still enrolled in college (Index 126).
- Consumers are price aware and coupon clippers, but open to impulse buys.
- They are attentive to environmental concerns.
- They are more comfortable with the latest technology than buying a car.

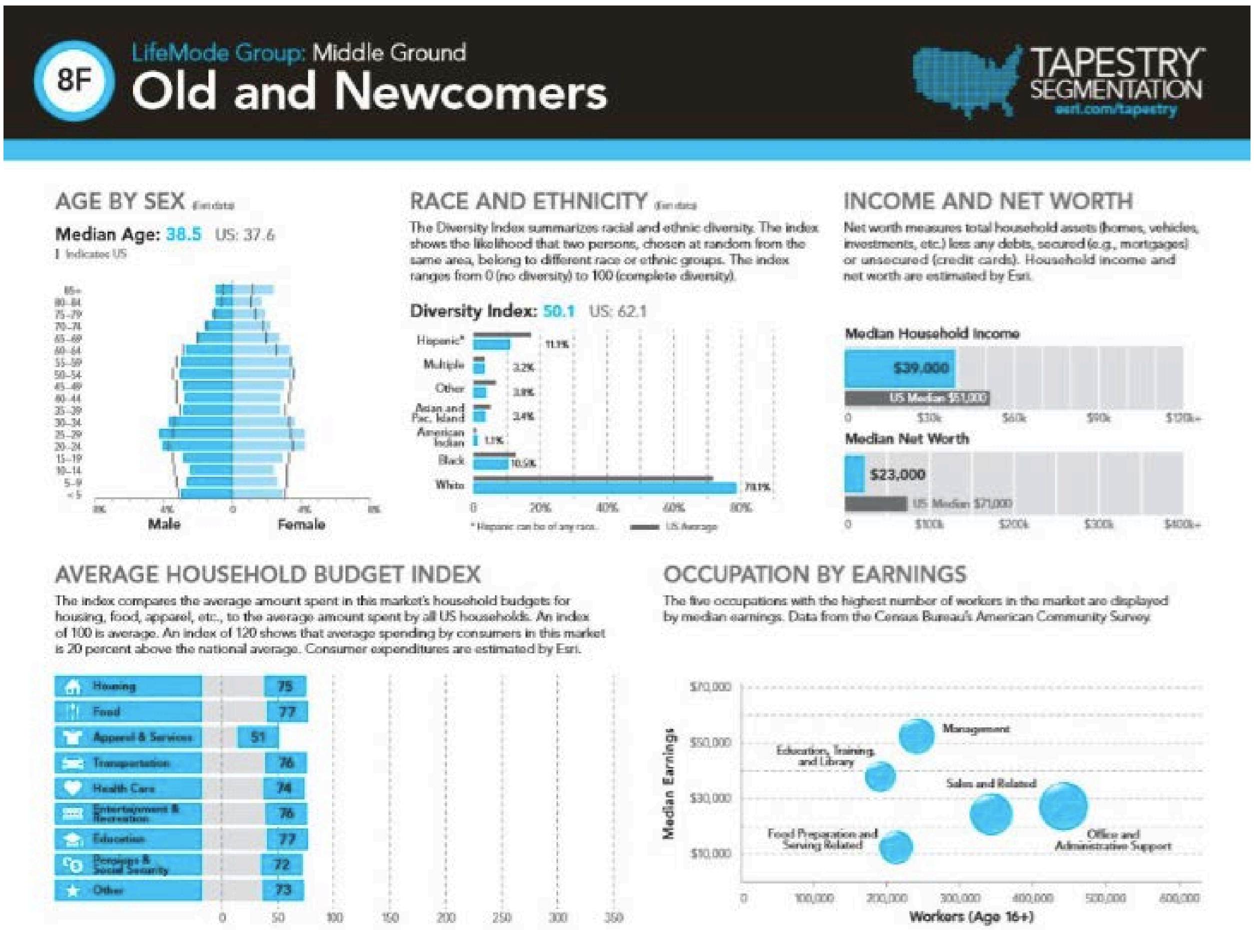
TAPESTRY SEGMENTATION
esri.com/tapestry

NORTH STAR DESTINATION STRATEGIES

COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

LEE'S SUMMIT TAPESTRY

TAPESTRY SEGMENTATION #4 : OLD & NEWCOMERS

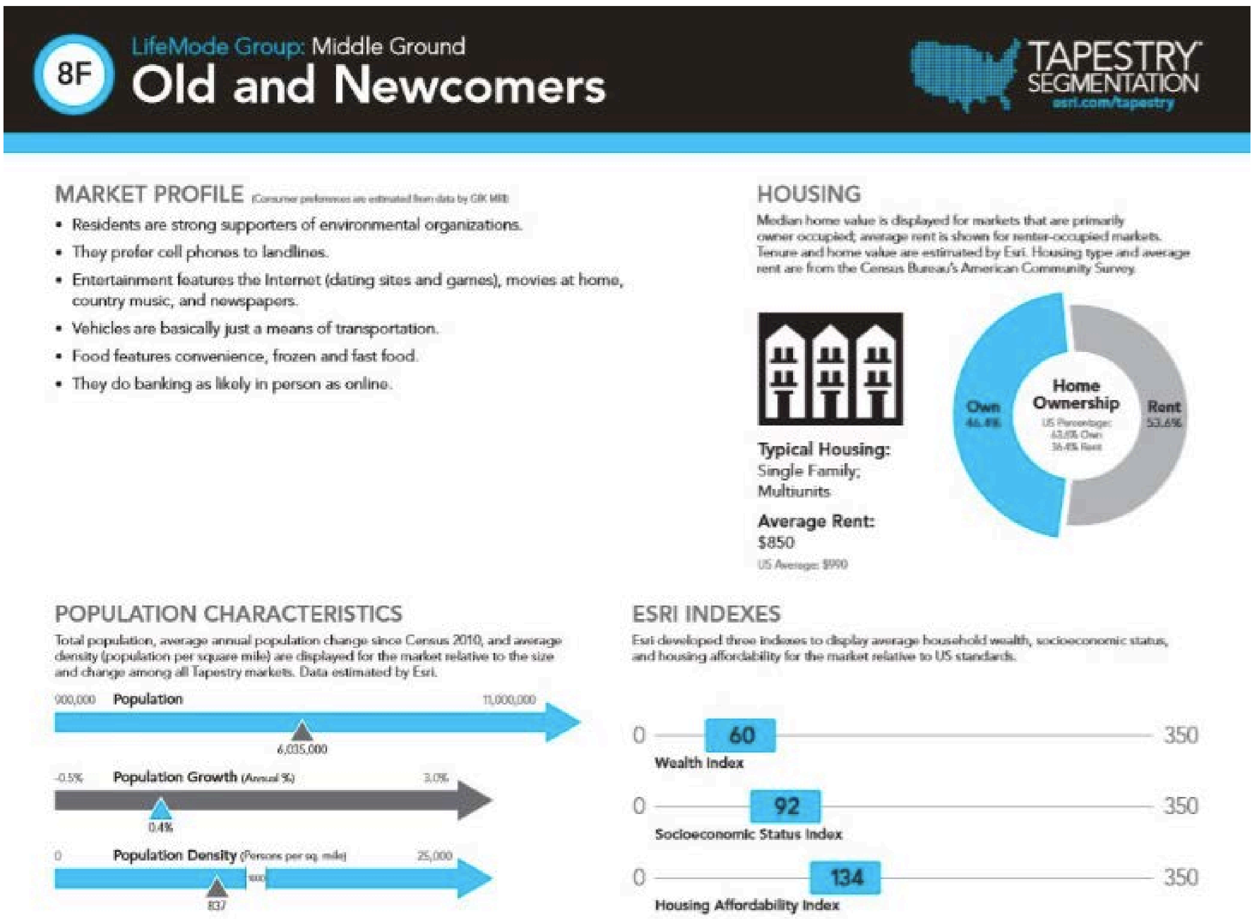


NORTH STAR DESTINATION STRATEGIES

COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

LEE'S SUMMIT TAPESTRY

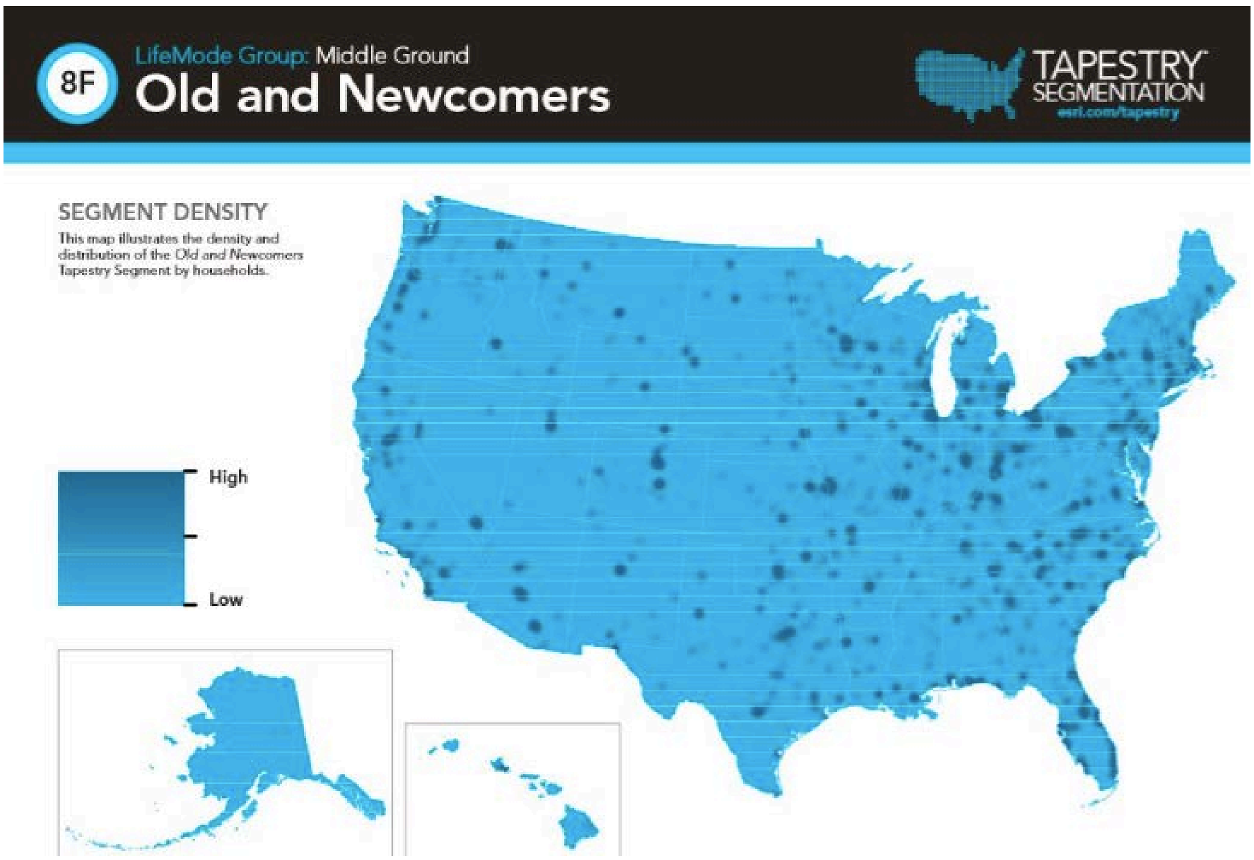
TAPESTRY SEGMENTATION #4 : OLD & NEWCOMERS



NORTH STAR DESTINATION STRATEGIES

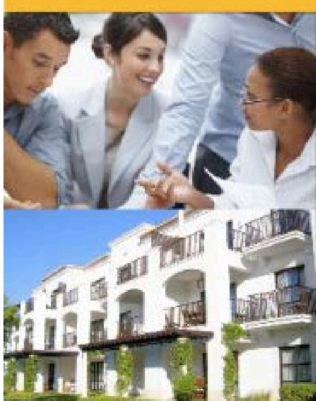
COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #4 : OLD & NEWCOMERS



LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #5: BRIGHT YOUNG PROFESSIONALS

The Bright Young Professionals tapestry segmentation is also noted in recent Lee's Summit data. Bright Young Professionals are typically young, educated professionals living on urban outskirts. Details and a description of The Bright Young Professionals tapestry segmentation are below.



LifeMode Group: Middle Ground

Bright Young Professionals

8C

Households: 2,613,000

Average Household Size: 2.40

Median Age: 32.2

Median Household Income: $50,000

WHO ARE WE?

Bright Young Professionals is a large market, primarily located in urban outskirts of large metropolitan areas. These communities are home to young, educated, working professionals. One out of three householders is under the age of 35. Slightly more diverse couples dominate this market, with more renters than homeowners. More than two-fifths of the households live in single-family homes; over a third live in 5+ unit buildings. Labor force participation is high, generally white-collar work, with a mix of food service and part-time jobs (among the college students). Median household income, median home value, and average rent are close to the US values. Residents of this segment are physically active and up on the latest technology.

OUR NEIGHBORHOOD

- Approximately 56% of the households rent; 44% own their homes.
- Household type is primarily couples, married (or unmarried), with above average concentrations of both single-parent (Index 125) and single-person (Index 115) households.
- Multiunit buildings or row housing make up 55% of the housing stock (row housing (Index 182), buildings with 5–19 units (Index 277)); 44% built 1980–99.
- Average rent is slightly higher than the US (Index 102).
- Lower vacancy rate is at 8.9%.

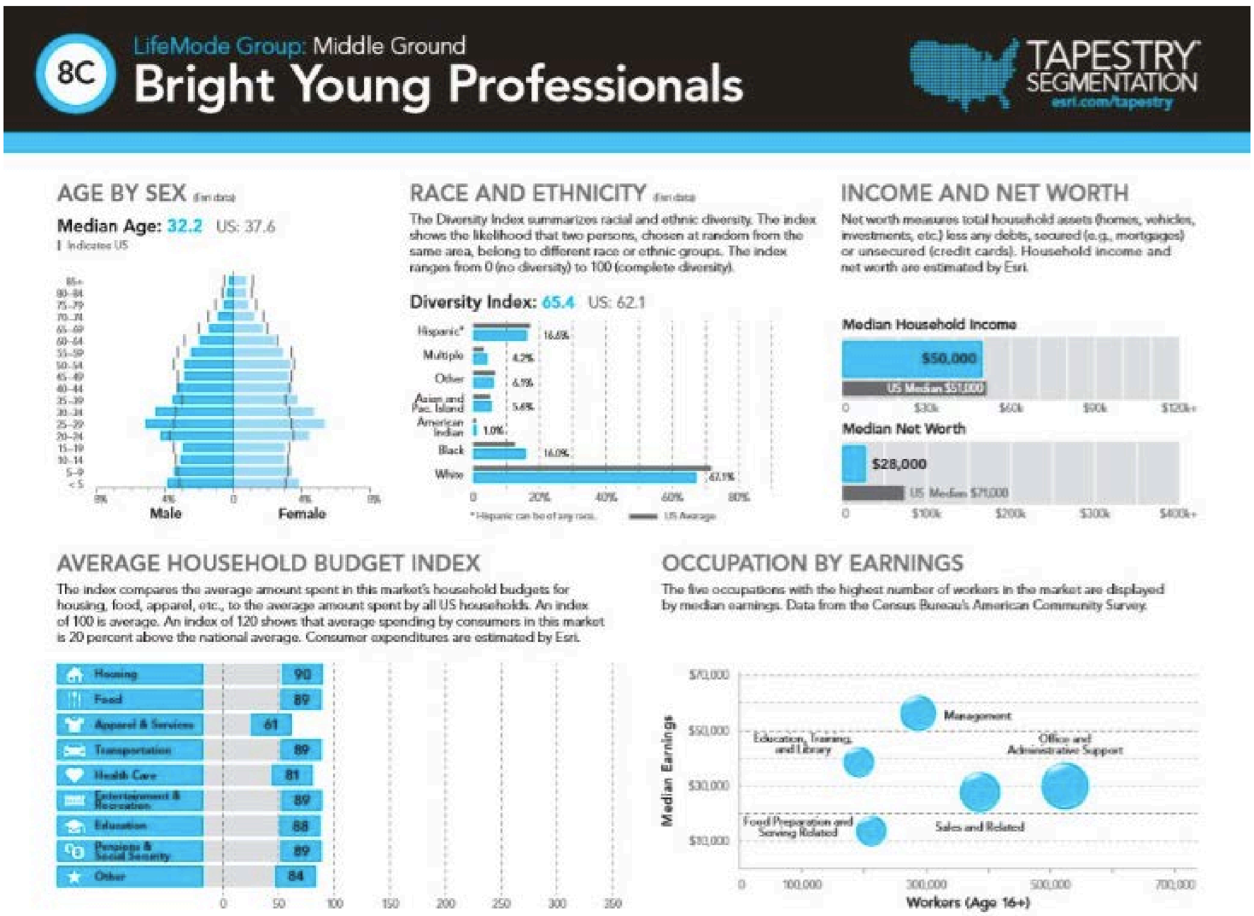
SOCIOECONOMIC TRAITS

- Education completed: 36% with some college or an associate's degree, 30% with a bachelor's degree or higher. Education in progress is 10% (Index 127).
- Unemployment rate is lower at 7.1%, and labor force participation rate of 73% is higher than the US rate.
- These consumers are up on the latest technology.
- They get most of their information from the Internet.
- Concern about the environment, impacts their purchasing decisions.

TAPESTRY SEGMENTATION
esri.com/tapestry

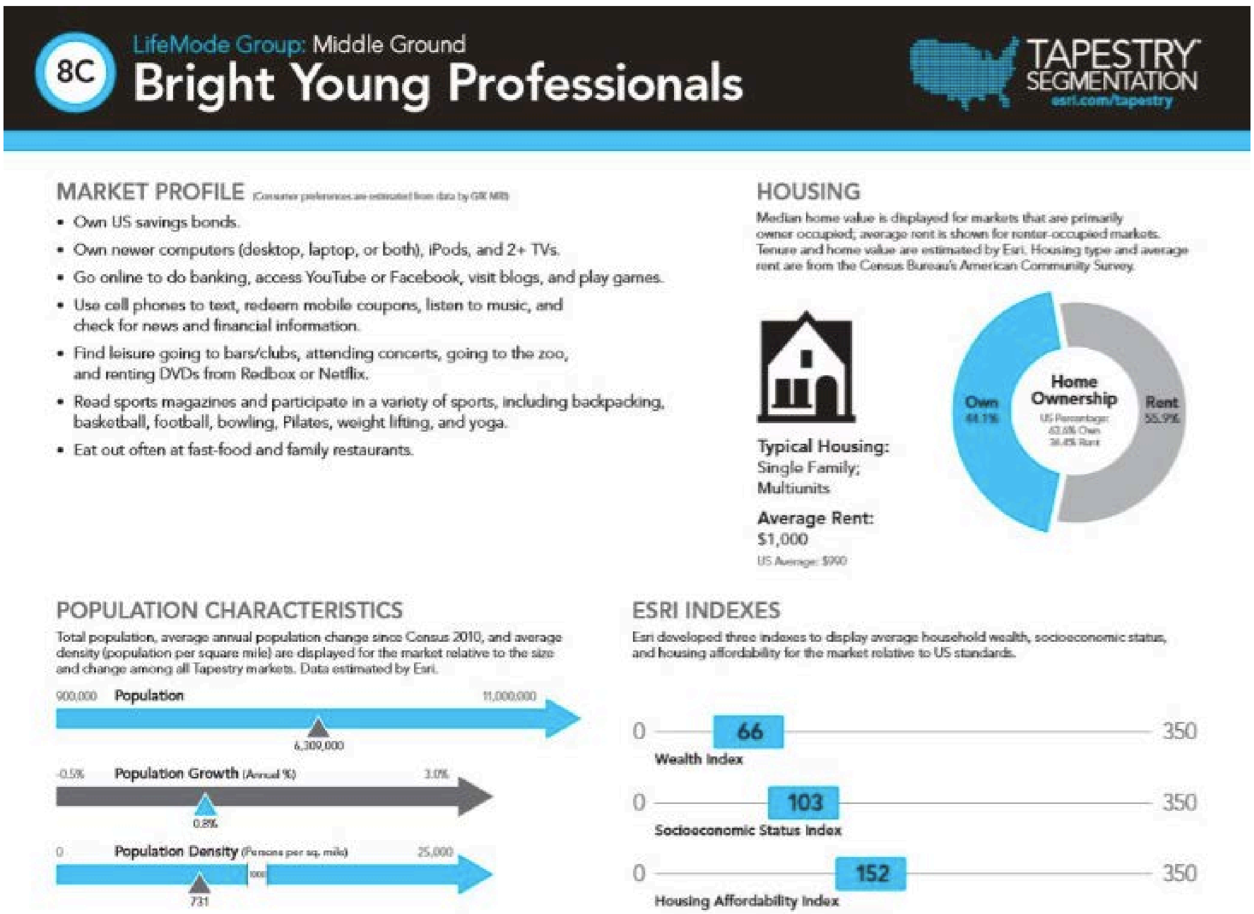
Note: The Index represents the ratio of the segment rate to the US rate multiplied by 100. Consumer preferences are estimated from data by GfK MRI.

LEE'S SUMMIT TAPESTRY
TAPESTRY SEGMENTATION #5: BRIGHT YOUNG PROFESSIONALS



LEE'S SUMMIT TAPESTRY

TAPESTRY SEGMENTATION #5: BRIGHT YOUNG PROFESSIONALS

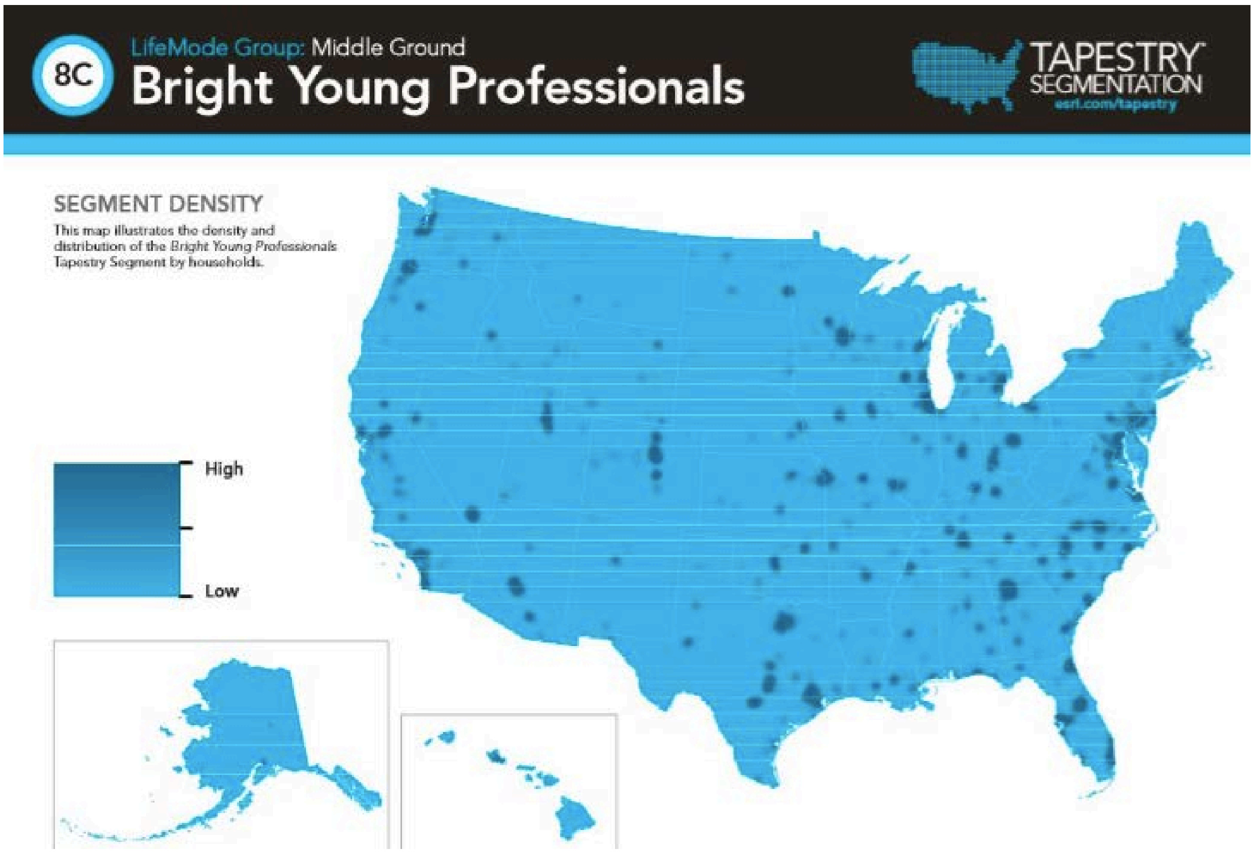


NORTH STAR DESTINATION STRATEGIES

COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS

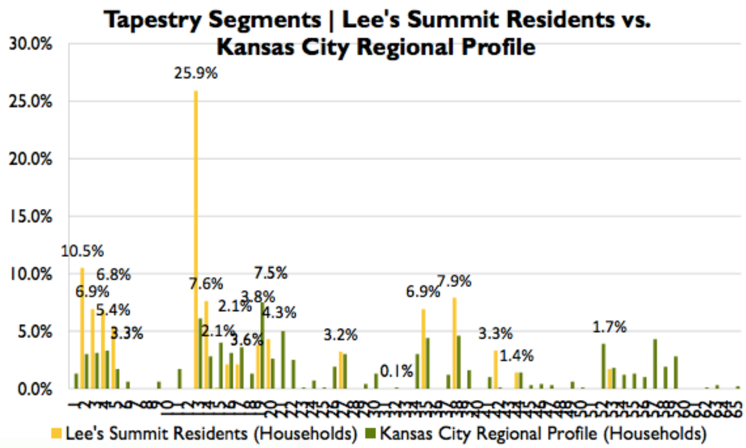
LEE'S SUMMIT TAPESTRY

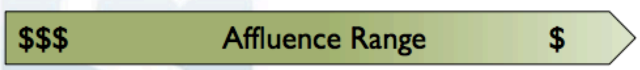
TAPESTRY SEGMENTATION #5: BRIGHT YOUNG PROFESSIONALS



NORTH STAR DESTINATION STRATEGIES

COMMUNITY MARKETING AND COMMERCIAL REAL ESTATE RESEARCH AND ANALYSIS





LifeMode Group: Family Landscapes

Soccer Moms

Soccer Moms is an affluent, family-oriented market with a country flavor. Residents are partial to new housing away from the bustle of the city but close enough to commute to professional job centers. Life in this suburban wilderness offsets the hectic pace of two working parents with growing children. They favor time-saving devices, like banking online or housekeeping services, and family-oriented pursuits.

- Education: 37.7% college graduates; more than 70% with some college education.
- Low unemployment at 5.9%; high labor force participation rate at 72%; 2 out of 3 households include 2+ workers (Index 124).

LifeMode Group: Affluent Estates

Professional Pride

Professional Pride consumers are well-educated career professionals that have prospered through the Great Recession. To maintain their upscale suburban lifestyles, these goal oriented couples work, often commuting far and working long hours. However, their schedules are fine-tuned to meet the needs of their school age children. They are financially savvy; they invest wisely and benefit from interest and dividend income. So far, these established families have accumulated an average of 1.5 million dollars in net worth, and their annual household income runs at more than twice the US level. They take pride in their newer homes and spend valuable time and energy upgrading. Their homes are furnished with the latest in home trends, including finished basements equipped with home gyms and in-home theaters.

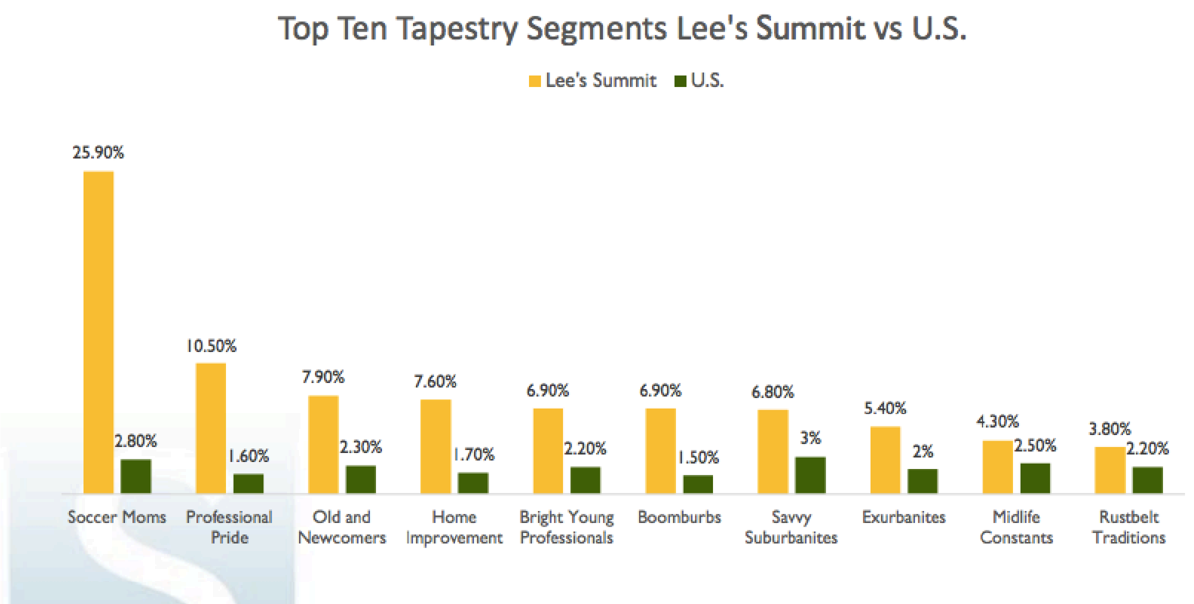
2011 vs 2015

2011

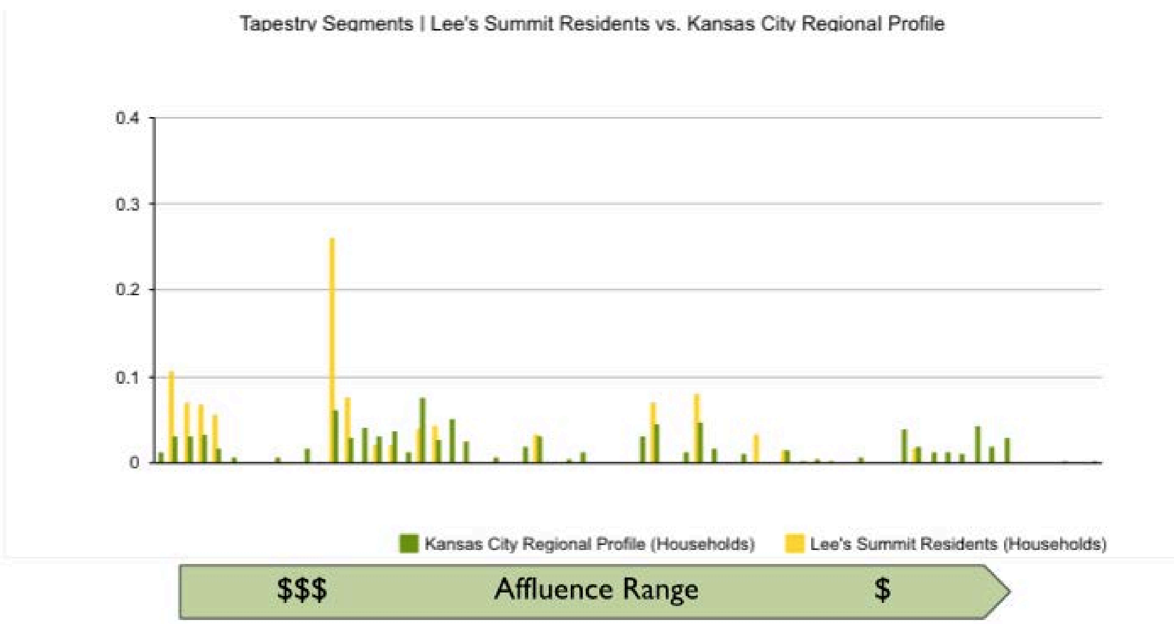
Residents		Kansas City Regional Profile	
12 Up and Coming Families	22.6%	32 Rustbelt Traditions	8.4%
04 Boomburbs	15.0%	12 Up and Coming Families	6.7%
06 Sophisticated Squires	11.7%	04 Boomburbs	5.5%
13 In Style	7.3%	19 Milk and Cookies	5.1%
28 Aspiring Young Families	6.2%	17 Green Acres	4.7%
02 Suburban Splendor	6.0%	18 Cozy and Comfortable	4.4%
33 Midlife Junction	5.6%	06 Sophisticated Squires	4.3%
48 Great Expectations	5.5%	28 Aspiring Young Families	4.2%
07 Exurbanites	5.4%	48 Great Expectations	3.9%
43 The Elders	4.8%	39 Young and Restless	3.5%

2015

Residents		Kansas City Regional Profile	
4A Soccer Moms	25.9%	5D Rustbelt Traditions	7.5%
1B Professional Pride	10.5%	4A Soccer Moms	6.1%
8F Old and Newcomers	7.9%	6A Green Acres	5.0%
4B Home Improvement	7.6%	8F Old and Newcomers	4.6%
8C Bright Young Professionals	6.9%	8C Bright Young Professionals	4.4%
1C Boomburbs	6.9%	12B Traditional Living	4.3%
1D Savvy Suburbanites	6.8%	4C Middleburg	4.0%
1E Exurbanites	5.4%	11B Young and Restless	3.9%
5E Midlife Constants	4.3%	5B In Style	3.6%
5D Rustbelt Traditions	3.8%	1D Savvy Suburbanites	3.3%



Top Ten Tapestry Segments Lee's Summit vs U.S.
Lee's Summit
U.S.
25.90%
2.80%
10.50%
1.60%
7.90%
2.30%
7.60%
1.70%
6.90%
2.20%
6.90%
1.50%
6.80%
3%
5.40%
2%
4.30%
2.50%
3.80%
2.20%
Soccer Moms
Professional Pride
Old and Newcomers
Home Improvement
Bright Young Professionals
Boomburbs
Savvy Suburbanites
Exurbanites
Midlife Constants
Rustbelt Traditions



Tapestry Segments | Lee's Summit Residents vs. Kansas City Regional Profile
0.4
0.3
0.2
0.1
0
Kansas City Regional Profile (Households)
Lee's Summit Residents (Households)
$$$
Affluence Range
$

Packet Information

File #: 2018-2374, **Version:** 1

Recommendations for the adoption of the 2018 International Residential Code (IRC)

Issue/Request:
Staff will present the CEDC with an overview of our code adoption process and stakeholder meetings. The presentation will note where stakeholders and staff agreed or disagreed with proposed amendments.

Key Issues:
Suggested local amendments and areas of disagreement with stakeholder groups are documented in the attached reports.

Background:
The City adopts a new building code every six years. Staff assembled stakeholder groups comprised of homebuilders, engineers and architects discussing and debating the code and any needed amendments.

Dan Harper, Mike Copeland, Tracy Diester

Recommendation: Staff reccomends the CEDC forward the 2018 IRC to the City Council

Committee Recommendation: I move that the CEDC forward the 2018 IRC to the City Council with staff's proposed amendments.

To: Community and Economic Development Committee
From: Development Services Department
Date: November 5, 2018
Re: 2018 International Residential Code Adoption

Before you are ordinance recommendations from staff for repealing the 2012 International Residential Code as adopted and adopting the 2018 International Residential Code with amendments. The International Code Council publishes new versions of codes for States, Counties and municipalities for adoption consideration. Staff has traditionally recommended review and adoption of these codes every 6 years primarily due to costs associated with the review, adoption and training that code adoption requires. The 6 year cycle also provides consistency among our region as it relates to code changes.

The adoption process begins with staff identifying a stakeholder group. This group works with staff in identifying changes to the code, establishing the change significance, and develops recommendations to changes the code as it's written. Staff has prepared a list of 5 significant changes to this code that can be found in the attachment titled "Proposed Significant Changes from the 2012 International Residential Code to the 2018". This process was completed with two points of emphasis that were not agreed on between staff's recommendation and the stakeholder group:

- Fire Protection of Floors. This section requires floors that are constructed of engineered wood products to be protected with the equivalent fire protection of a layer of ½" gypsum board. The intent of this section is to provide fire fighters time in order to fight fires, or save people in fires that may occur in homes with this type of construction. Attached in this packet are two independent fire reports, three photos of a structure fire in Lee's Summit with this type of floor construction, and a publication from the American Plywood Association illustrating ways to comply with this code section.
  This is not a change from the current adopted code. This provision was adopted by ordinance in the 2012 International Residential Code.
- Arc-fault circuit-interrupter protection. This section of the code requires all 15 and 20 amp outlets in new dwellings to be protected by an arc-fault device. These devices reduce the amount of fires in dwellings that occur as a

result of electrical arcing. Attached in this packet are two items that support staff's position: Electrical Fact Sheet, and AFCI's Come of Age.
The current ordinance requires these devices be installed on outlets located in bedrooms.

In addition, there are 3 more attachments in this packet prepared by members of our stakeholders group illustrating their position on these two topics as well as other topics. They are titled: KCHBA 2018 Suggested Amendments to IRC, KCHBA's Position Fire Protection I-joists and KCHBA's Position-How fire safe are homes.

Staff also participated in a group comprised of representatives of other municipalities throughout the metropolitan area. The focus of this group was to collaborate with these jurisdictions as they related to code adoption in order to bring a level of consistency across the metropolitan area as they relate to code requirements.

On October 18th, staff presented these proposed ordinances to the Board of Appeals. The stakeholder group was present and presented their position on these two items at that time. The Board of Appeals meeting concluded with a motion to move forward in the process and present these ordinances to the Community and Economic Development Council as prepared by staff.

In conclusion, Staff feels the proposed code adoption incorporates new provisions and amendments that are reasonable and justified. The proposed ordinances provide better safeguards in protecting the public as they relate to residential construction.

BILL NO. 18-

AN ORDINANCE REPEALING CHAPTER 7, LEE'S SUMMIT BUILDING CODE OF THE CODE OF ORDINANCES OF THE CITY OF LEE'S SUMMIT, MISSOURI, AND ENACTING A NEW CHAPTER 7 PERTAINING TO THE SAME SUBJECT MATTER, FOR THE CITY OF LEE'S SUMMIT, MISSOURI.

WHEREAS, the 2018 International Building Code, 2018 International Residential Code, 2017 National Electrical Code, 2018 International Plumbing Code, 2018 International Mechanical Code, 2018 International Fuel Gas Code and other revised building regulations have been extensively reviewed by the Codes Administration Department, the Fire Department, the Board of Appeals, members of professional trade associations, members of the construction community, and the Community & Economic Development Committee; and

WHEREAS, after much technical study and ample public input, the Codes Administration Department, the Board of Appeals, and the Community & Economic Development Committee believe that it is in the best interests of the City of Lee's Summit to repeal in its entirety Chapter 7, Building and Building Regulations of the Code of Ordinances of the City of Lee's Summit, Missouri to remain current with the most recently published International Codes, including the 2018 International Building Code, the 2018 International Residential Code, the 2011 National Electrical Code, the 2018 International Plumbing Code, the 2018 International Mechanical Code, the 2018 International Fuel Gas Code, and State law; and

WHEREAS, based on staff reports and public comment, the City Council desires to protect the public health, safety, and welfare by repealing Chapter 7 and enacting a new Chapter 7 pertaining to the same subject matter; and

WHEREAS, The City of Lee's Summit pursuant to the Lee's Summit City Charter, the Missouri State Constitution, and the City's police powers has the authority to regulate for the public health, safety, and welfare;

NOW, THEREFORE, BE IT ORDAINED BY THE COUNCIL OF THE CITY OF LEE'S SUMMIT, MISSOURI, as follows:

SECTION 1. That Chapter 7, Building and Building Regulations, of the Code of Ordinances of the City of Lee's Summit, Missouri, is hereby repealed in its entirety and a new Chapter 7 is enacted, pertaining to the same subject matter, to read as follows:

7-900. - INTERNATIONAL RESIDENTIAL CODE ADOPTED. The 2018 edition of the International Residential Code, including appendices E, H, and J, and its most current errata as published by the International Code Council is hereby adopted and incorporated in this chapter as fully as if set forth herein, excepting only such parts or portions thereof as are specifically added or amended.

7-901. - INTERNATIONAL RESIDENTIAL CODE DELETED; CHAPTER 1. ADMINISTRATION. Chapter 1, entitled Administration is hereby deleted. (See Article I of this Chapter)

7-902. - INTERNATIONAL RESIDENTIAL CODE DATA ENTRY; TABLE R301.2(1). TABLE R301.2(1) CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA. Table R301.2(1) shall include the following data:

Ground Snow Load: Twenty (20) pounds per square foot.

Wind Speed: Ninety (90) miles per hour.

Seismic Design Category: A

Weathering: Severe.

Frost Line Depth: Thirty-six (36) inches.

Termite: Moderate to Heavy

Decay: Slight to Moderate.

Winter Design Temperature: Six (6) degrees Fahrenheit.

Ice Shield Underlayment Required: Yes

Flood Hazards: See Article

Air Freezing Index: 927

Mean Annual Temperature: 55.5 degrees Fahrenheit

Manual J Design Criteria is hereby Deleted

7-903. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R302.5.1 OPENING PROTECTION. Section R302.5.1 Opening Protection is amended to read as follows: Openings from a private garage directly into a room used for sleeping purposes shall not be permitted. Other openings between the garage and residence shall be equipped with solid wood doors not less than 1 3/8ths inches (35mm) in thickness, solid or honeycomb core steel doors not less than 1 1/8ths inches (35mm) thick, or 20 minute fire-rated doors, equipped with a self closing device.

Exception: Attic access openings shall not be required to be equipped with a self closing device.

7-904. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R303.3 BATHROOMS. Section R303.3 is hereby amended to read as follows: Bathrooms, water closet compartments and other similar rooms shall be provided with aggregate glazing area in windows of not less than 3 square feet (0.279 m2), one-half of which must be openable.

EXCEPTION: The glazed areas shall not be required where artificial light and a mechanical ventilation system are provided. The minimum ventilation rates shall be 50 cfm (23.6L/s) for intermittent ventilation or 20 cfm (9.4 L/s) for continuous ventilation. Ventilation air from the space shall be exhausted directly to the outside or to an attic ventilated in accordance with Section R806. The point of discharge of the exhaust air shall be at least 3 feet from any opening into the building. Bathrooms which contain only a water closet or lavatory, or combination thereof, and similar rooms, may be ventilated with an approved mechanical recirculating fan or similar device designed to remove odors from the air.

7-905. - INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R303.4 MECHANICAL VENTILATION. Section R303.4 Mechanical Ventilation is hereby deleted.

7-906. – INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R311.3.2 FLOOR ELEVATIONS FOR OTHER EXTERIOR DOORS. Section R311.3.2 Floor elevations for other exterior doors is hereby amended to read as follows: Doors other than the required egress door shall be provided with landings or floors not more than 7 ¾ inches (196 mm) below the top of the threshold.

EXCEPTION:

A landing is not required where a stairway of four or fewer risers is located on the exterior side of the door, provided the door does not swing over the stairway.

7-907.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R311.7.8.5 GRIP SIZE. Section R311.7.8.5 is hereby amended to read as follows; All required handrails shall be of one of the following types or provide equivalent graspability.

1. Type I. Handrails with a circular cross section shall have an outside diameter of at least 1-1/4 inches (32mm) and not greater than 2 inches (51 mm). If the handrail is not circular it shall have a perimeter dimension of at least 4 inches (102 mm) and not greater than 6-1/4 inches (160 mm) with a maximum cross section of dimension of 2-1/4 inches (57 mm).

2. Type II. Handrails with a perimeter greater than 6-1/4 inches (160mm) shall provide a graspable finger recess area on both sides of the profile. The finger recess shall begin within a distance of 3/4 inch (19 mm) measured vertically from the tallest portion of the profile and achieve a depth of at least 5/16 inch (8mm) within 7/8 inch (22mm) below the widest portion of the profile. This required depth shall continue for at least 3/8 inch (10mm) to a level that is not less than 1-3/4 inches (45 mm) below the tallest portion of the profile. The minimum width of the

handrail above the recess shall be 1-1/4 inches (32 mm) to a maximum of 2-3/4 inches (70mm). Edges shall have a minimum radius of 0.01 inches (0.25 mm).

EXCEPTION:

Handrails provided at other non-required exterior stairs may have a maximum horizontal cross-sectional dimension of 3-1/2 inches and shall be easily graspable.

7-908. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R313 AUTOMATIC FIRE SPRINKLER SYSTEMS. Section R313 is hereby amended to read as follows: A builder of a one-and two family dwelling or townhouse shall offer to any purchaser, on or before the time of entering into the purchase contract the option, at the purchaser's cost, to install or equip fire sprinklers in the one-and two-family dwelling or townhouse. Notwithstanding any other provision of law to the contrary, no purchaser of such one- and two family dwelling or townhouse shall be denied the right to install a fire sprinkler system in such dwelling or townhouse being purchased. The provisions of this section, which are intended to mirror the requirements of section RSMo 67.281, shall expire on December 31st, 2022.

7-909. - INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R313.1 TOWNHOUSE AUTOMATIC FIRE SPRINKLER SYSTEMS. Section R313.1 Townhouse automatic fire sprinkler systems is hereby deleted.

7-910. - INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R313.2 ONE- AND TWO FAMILY DWELLING AUTOMATIC FIRE SYSTEMS. Section R313.2 One- and two family dwellings automatic fire systems is hereby deleted.

7-911. - INTERNATIONAL RESIDENTIAL CODE DELETED; R317.1.1 FIELD TREATMENT. Section R317.1.1 is hereby deleted.

7-912. - INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R318.1.2 FIELD TREATMENT. Section R318.1.2 is hereby deleted.

7-913. – INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R326 SWIMMING POOLS, SPAS AND HOT TUBS. Section 326 is hereby deleted.

7-914. - INTERNATIONAL RESIDENTIAL CODE ADDED; SECTION R401.3.1 MINIMUM STANDARDS. Section R401.3.1 is hereby added to read as follows: A. Minimum standards: All drainage facilities shall be designed to carry waters to the nearest drainage way, storm sewer conveyance, or other approved point of collection and conveyance. Erosion of ground in the area of discharge shall be prevented by installation of erosive control devices. Unless specified drainage ways and swales are specifically approved by the building official, abutting property lines between structures shall be designed to function as drainage ways. The toe of slopes shall set back from the property line a minimum of one foot. The area surrounding the building foundation shall have a drainage gradient as provided for in the International

Residential Code, as amended from time to time with a draining gradient thereafter of not less than two percent toward approved drainage facilities unless waived by the building official.

B. Prohibited conduct: No person shall allow or cause any:

1) Obstruction to be created, installed or maintained within any drainage way, detention facility, or engineered swale which will create ponding on adjacent property, divert water onto the adjoining property, or impede drainage. Fences may be erected in such areas provided they do not unnecessarily restrict the flow of water.

2) Water from intermittent sources such as discharges from sump pumps, downspouts, foundation drains, swimming pools, swimming pool backwashes, or other similar sources excluding lawn sprinklers to be discharged closer than five feet to any adjoining property line.

C. Enforcement: Where such conditions exist and the code official has given written notice of the violation, the owner of the property shall take appropriate measures to eliminate the problems caused on the adjacent property, within the time period stated in the notice, and failure to do so shall be a violation of this chapter.

7-915. - INTERNATIONAL RESIDENTIAL CODE ADDED; SECTION R403.1.1.1 FOOTING REINFORCEMENT. Section R403.1.1.1 is hereby added to read as follows; Footings for basement foundation walls shall have a minimum reinforcement consisting of not less than two No. 4 bars, uniformly spaced, located a minimum of 3 inches clear from the bottom and edges of the footing.

7-916. - INTERNATIONAL RESIDENTIAL CODE ADDED. SECTION R403.1.1.2 COLUMN PADS. Section R403.1.1.2 is hereby added and reads as follows; Unless specified otherwise, column pads shall be a minimum of 24 inches by 24 inches and 8 inches deep (24” x 24” x 8”). Reinforcement shall consist of a minimum of three No. 4 bars each way, uniformly spaced, within each column pad.

7-917. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R404.1.7 BACKFILL PLACEMENT. Section R404.1.7 is hereby amended to read as follows; Backfill shall not be placed against the wall until the wall has sufficient strength or has been sufficiently braced to prevent damage by the backfill.

EXCEPTION: Such bracing is not required for walls supporting less than 4 feet (1219 mm) of unbalanced backfill.

7-918. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R405.2.3 DRAINAGE SYSTEM. Section R405.2.3 is hereby amended to read as follows: A sump shall be provided to drain the porous layer, footings, and foundations that retain earth and enclose habitable or usable space located below grade that do not drain and discharge by gravity to an approved storm sewer system or to daylight. The sump shall be at least 24 inches (610mm) in diameter or 20 inches square (0.0129 m2), shall extend at least 24 inches (610mm) below the bottom of the basement floor and shall be capable of positive gravity or mechanical drainage to remove any accumulated water. Sumps receiving storm water from any exposed exterior drain(s) or opening(s) shall be provided with back-up system(s) capable of assuring proper sump operation in case of power failure. The drainage system shall discharge into an approved storm sewer system or to daylight.

7-919. - INTERNATIONAL RESIDENTIAL CODE ADDED; SECTION R506.2.5 INTERIOR UNDERSLAB DRAINS. Section R506.2.5 is hereby added to read as follows: Where foundations retain earth and enclose habitable or usable space located below grade, drains shall be provided below the floor slab. Drainage tiles, perforated pipe or other approved systems or materials shall be installed at or below the area(s) to be protected; shall be placed with positive or neutral slope to minimize the accumulation of deposits in the drainage system; and shall discharge by gravity or mechanical means to an approved storm water drainage system. The underslab drainage system shall be installed around the inner perimeter of the area(s) to be protected, or, in a manner that will provide adequate drainage for all area(s) to be protected and is approved by the building official. Interior underslab drains installed on uncompacted fill material shall be supported by mechanical means which are adequately tied into the concrete slab to ensure proper drainage throughout the underslab drain(s).

7-920. – INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R507.9.2 LATERAL CONNECTION. Section R507.9.2 is hereby deleted.

7-921. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R602.1 DRILLING AND NOTCHING OF THE TOP PLATE. Section R602.1 Drilling and notching of the top plate is amended to read as follows: When piping or ductwork is placed in or partly in an exterior wall or interior load bearing wall, necessitating cutting, drilling or notching of the top plate by more than 50 percent of its width, a galvanized metal tie not less than 0.054 inch thick (1.37 mm) (16 ga) and 1 ½ inches (38 mm) wide shall be fastened across and to the plate at each side of the opening with not less than four 10d (0.148 inch diameter) having a minimum length of 1 ½ inches (38 mm) at each side or equivalent. The metal tie must extend a minimum of 6 inches past the opening. See figure R602.6.1

EXCEPTION: When the entire side of a wall with the notch or cut is covered by wood structural panel sheathing.

7-922. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R801.3 ROOF DRAINAGE. Section R801.3 is hereby amended to read as follows: All dwellings shall have a controlled method of water disposal from roofs that will collect and discharge all roof drainage to the ground surface at least three (3) feet from foundation walls or to an approved drainage system.

7-223. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R902.1. ROOF COVERING MATERIALS. Section R902.1 Roofing covering materials is hereby amended to read as follows: Roofs shall be covered with materials as set forth in Sections R904 and R905.

Except where the code requires greater protection, roof coverings for new buildings or structures or additions thereto, or roof coverings utilized for re-roofing shall be a minimum of Class C. Class A, B or C roofing shall be installed in areas designated by law as requiring their use or when the edge of the roof is less than 3 feet (914 mm) from a property line. Classes A, B and C roofing required to be listed by this section shall be tested in accordance with UL 790 or ASTM E 108. Roof assemblies with coverings of brick, masonry, slate, clay or concrete roof tile, exposed concrete roof deck, ferrous or copper shingles or sheets, and metal sheets and shingles, shall be considered Class A roof coverings.

7-224. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R907.1 GENERAL. Section R907.1 is hereby amended to read as follows: Materials and methods of application used for re-covering or replacing an existing roof covering shall comply with the requirements of Chapter 9 as amended. Re-roofing includes any repairs of more than 10% of the total roof covering in any three year period. A repair of 10% or less of the total roof covering in any three year period may utilize approved roofing materials comparable to the existing roofing materials.

EXCEPTION: Re-roofing shall not be required to meet the minimum design slope requirement of one-quarter unit vertical in 12 units horizontal (2-percent slope) in Section R905 for roofs that provide positive roof drainage.

7-225. - INTERNATIONAL RESIDENTIAL CODE DELETED; CHAPTER 11. Chapter 11 is hereby deleted.(See Article 8 of this chapter)

7-226. - INTERNATIONAL RESIDENTIAL CODE DELETED; CHAPTER 12. MECHANICAL ADMINISTRATION. Chapter 12 is hereby deleted. (See article 1 of this chapter)

7-227. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION M1501.1 OUTDOOR DISCHARGE. Section M1501.1 is hereby amended to read as follows: The air removed by every mechanical exhaust system shall be discharged to the outdoors. Air shall not be exhausted into an attic, soffit, ridge vent or crawl space.

EXCEPTIONS:

1.) Whole-house ventilation-type attic fans that discharge into the attic space of dwelling units having private attics shall be permitted.

2.) Bathroom exhaust fans installed in accordance with amended section R303.3.

7-228. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION M1507.2 RECIRCULATION OF AIR. Section M1507.2 is hereby amended to read as follows: Exhaust air from bathrooms and toilet rooms shall not be recirculated within a residence or to another dwelling unit and shall be exhausted in accordance with amended section R303.3.

7-229.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION G2414.5.2 COPPER TUBING. Section G2414.5.2 is hereby amended to read as follows: Copper tubing shall comply with standard Type K or L of ASTM B 88 or ASTM B 280. Copper and brass tubing shall not be utilized to distribute natural gas nor shall it be utilized to distribute any other fuel gas within a building or structure.

7-330. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION G2417.4.1 TEST PRESSURE. Section G2417.4.1 is hereby amended to read as follows; The test pressure to be used shall be not less than one and one-half times the proposed maximum working pressure, but not less than 10 psig (68.9kPa) irrespective of design pressure. For welded piping, and for piping carrying gas at pressures in excess of fourteen (14) inches water column pressure, the test pressure shall not be less than 60 psig. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe.

7-331. - INTERNATIONAL RESIDENTIAL CODE DELETED; CHAPTER 25. PLUMBING ADMINISTRATION. Chapter 25 is hereby deleted. (See Article 1 of this chapter)

7-332. - INTERNATIONAL RESIDENTIAL CODE ADDED; SECTION P2601.2.1 PROHIBITED DRAINAGE AND CONNECTIONS. Section P2601.2.1 is hereby added to read as follows: Sanitary sewer systems shall be designed, built and maintained in such a manner to prevent all storm or ground water from draining, discharging or entering into the sanitary sewer system. Connection of sump pumps, foundation drains, yard drains, gutter downspouts and any other storm water drainage receptacle(s) or system(s) are specifically prohibited from being connected to the sanitary sewer system.

7-333. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P2603.5 FREEZING. Section P2603.5 is hereby amended to read as follows: Water, soil or waste pipe shall not be installed outside of a building, in exterior walls, in attics or crawl spaces, or in any other place subjected to freezing temperature unless adequate provision is made to protect it from freezing by insulation or heat or both. Water service pipe shall be installed not less than 42 inches in depth below grade.

7-334. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P2603.5.1 SEWER DEPTH. Section P2603.5.1 is hereby amended to read as follows: Building sewers shall be a minimum of 12 inches below grade.

7-335.- INTERNATIONAL RESIDENTIAL CODE ADDED; SECTION P2604.5 INSPECTION. Section P2604.5 is hereby added to read as follows: Excavations required for the installation of a building drainage system shall be open trench work and shall be kept open until the piping has been inspected and approved to cover.

7-336.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P2902.5.3 LAWN IRRIGATION SYSTEMS. Section P2902.5.3 is hereby amended to read as follows: The potable water supply to lawn irrigation systems shall be protected against backflow by a device approved by the Missouri Department of Natural Resources. Backflow devices installed within structures shall be installed a minimum of 6 inches away from any wall or vertical obstruction. The backflow device shall be installed between 12 inches and 48 inches above the floor and shall be accessible.

7-337.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P2902.6.2 PROTECTION OF BACKFLOW PREVENTERS. Section P2902.6.2 Protection of backflow preventers is hereby amended to read as follows: Backflow preventers shall not be located in areas subject to freezing except where they can be removed by means of unions, or are protected by heat, insulation or both.

EXCEPTION: In-ground backflow preventers installed for lawn irrigation systems.

7-338. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P3002.2 BUILDING SEWER. Section P3002.2 is hereby amended to read as follows: Building sewer piping shall be as shown in Table P3002.2. Forced main sewer piping shall conform to one of the standards for ABS plastic pipe, cast-iron pipe, copper or copper-alloy tubing, PVC plastic pipe, or pressure-rated pipe listed in Table P3002.2. In addition, building sewer piping shall be a minimum of schedule 40 PVC/ABS or equivalent unless otherwise approved by the building official.

7-339.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P3005.4.2 BUILDING DRAIN AND SEWER SIZE AND SLOPE. Section P3005.4.2 is hereby amended to read as follows: Pipe sizes and slope shall be determined from Table P3005.4.2 on the basis of drainage load in fixture units (d.f.u.) computed from Table P3004.1. The minimum size of a building sewer serving a dwelling unit shall be four inches.

7-340.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P3114.3 WHERE PERMITTED. Section P3114.3 is hereby amended to read as follows: Individual vents, branch vents, circuit vents and stack vents shall be permitted to terminate with a connection to an air admittance valve only when approved by the Administrative Authority.

7-341. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION E3601.6.2 SERVICE DISCONNECT LOCATION. Section E3601.6.2 is hereby amended to read as follows: The service disconnecting means shall be installed at a readily accessible location either outside of a building or inside nearest the point of entrance of the service conductors. When service conductors are more than 10 feet in length from the point of entry to the service panel, a separate means of disconnect shall be installed at the service cable entrance to the building or structure. Service disconnecting means shall not be installed in bathrooms. Each occupant shall have access to the disconnect serving the dwelling unit in which they reside.

7-342.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION E3901.4.5 RECEPTACLE OUTLET LOCATION. Section E3901.4.5 Receptacle outlet location is hereby amended to read as follows: Receptacle outlets shall be located not more than 20 inches (508 mm) above the countertop or work surface. Receptacle outlet assemblies installed in countertops and work surfaces shall be listed for use in countertops or work surfaces.

Receptacle outlets rendered not readily accessible by appliances fastened in place, appliance garages, sinks or rangetops as addressed in the exception to Section 3901.4.1, or appliances occupying dedicated space shall not be considered as these required outlets.

EXCEPTION: Receptacle outlets shall be permitted to be mounted not more than 12 inches (305 mm) below the countertop or work surface in construction designed for the physically impaired or for island and peninsular countertops or work surface where the surface is flat across its entire surface and the are no means to mount a receptacle within 20 inches (508 mm) above the countertop, such as in an overhead cabinet. Receptacles mounted below the countertop or work surface in accordance with this section shall not be located where the countertop or work surface extends more than 6 inches (152 mm) beyond its support base.

7-343.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION E3902.2 GARAGE AND ACCESSORY BUILDING RECEPTACLES. Section E3902.2 Garage and accessory building receptacles is hereby amended to read as follows: All 125-volt, single-phase, 15- and 20- ampere receptacles installed in garages and grade level portions of unfinished accessory buildings used for storage or work areas shall have ground-fault circuit interrupter protection for personnel.

EXCEPTIONS:

1.) Receptacles that are not readily accessible such as a ceiling mounted receptacle for a garage door opener.

2.) A single receptacle supplied by a dedicated branch circuit that is located and identified for a specific use by a cord-and-plug-connected appliance such as a refrigerator, freezer or sump pump.

3.) A receptacle supplying only a permanently installed fire alarm or burglar alarm system.

7-344. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION E3902.5 UNFINISHED BASEMENT RECEPTACLES. Section E3902.5 Unfinished basement receptacles is hereby amended to read as follows: All 125-volt, single phase, 15- and 20- ampere receptacles installed in unfinished basements shall have ground fault circuit interrupter protection for personnel. For the purposes of this section, unfinished basements are defined as portions or areas of the basement not intended as habitable rooms and limited to storage areas, work areas, and the like.

Exceptions:

1.) Receptacles that are not readily accessible such as a ceiling mounted receptacle for a garage door opener.

2.) A single receptacle supplied by a dedicated branch circuit that is located and identified for a specific use by a cord-and-plug-connected appliance such as a refrigerator, freezer or sump pump.

3.) A receptacle supplying only a permanently installed fire alarm or burglar alarm system.

SECTION 2. That it is the intention of the City Council and it is hereby ordained that the provisions of this ordinance shall become and be made a part of the Code of Ordinances for the City of Lee's Summit, Missouri.

SECTION 3. That this ordinance shall be in full force and effect on April 1, 2019 after the date of its passage and adoption, and approval by the Mayor.

SECTION 4. That if any section, subsection, sentence, clause, phrase or portion of this Ordinance is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such portion shall be deemed a separate and independent provision and such holding shall not affect the validity of the remaining portions thereof.

PASSED by the City Council of the City of Lee's Summit, Missouri, this ________day of ____________________________, 2018.

____
Mayor *William A. Baird*

ATTEST:

____
City Clerk *Trisha Fowler Arcuri*

APPROVED by the Mayor of said city this _____ day of ____________________, 2018.

____
Mayor *William A. Baird*

ATTEST:

____
City Clerk *Trisha Fowler Arcuri*

APPROVED AS TO FORM:

____
City Attorney *Brian W. Head*

2018 International Residential Code Amendments

7-900. - INTERNATIONAL RESIDENTIAL CODE ADOPTED. The 2018 edition of the International Residential Code, including appendices E, H, and J, and its most current errata as published by the International Code Council is hereby adopted and incorporated in this chapter as fully as if set forth herein, excepting only such parts or portions thereof as are specifically added or amended.

7-901. - INTERNATIONAL RESIDENTIAL CODE DELETED; CHAPTER 1. ADMINISTRATION. Chapter 1, entitled Administration is hereby deleted. (See Article I of this Chapter)

7-902. - INTERNATIONAL RESIDENTIAL CODE DATA ENTRY; TABLE R301.2(1). TABLE R301.2(1) CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA. Table R301.2(1) shall include the following data:

Ground Snow Load: Twenty (20) pounds per square foot.

Wind Speed: Ninety (90) miles per hour.

Seismic Design Category: A

Weathering: Severe.

Frost Line Depth: Thirty-six (36) inches.

Termite: Moderate to Heavy

Decay: Slight to Moderate.

Winter Design Temperature: Six (6) degrees Fahrenheit.

Ice Shield Underlayment Required: Yes

Flood Hazards: See Article

Air Freezing Index: 927

Mean Annual Temperature: 55.5 degrees Fahrenheit

Manual J Design Criteria is hereby Deleted

-Added design criteria specific to this region.

7-903. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R302.5.1 OPENING PROTECTION. Section R302.5.1 Opening Protection is amended to read as follows: Openings from a private garage directly into a room used for sleeping purposes shall not be permitted. Other openings between the garage and residence shall be equipped with solid wood doors not less than 1 3/8ths inches (35mm) in thickness, solid or honeycomb core steel doors not less than 1 1/8ths inches (35mm) thick, or 20 minute fire-rated doors, equipped with a self closing device.

Exception: Attic access openings shall not be required to be equipped with a self closing device.

-States that a self closing device is not required on attic access openings

7-904. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R303.3 BATHROOMS. Section R303.3 is hereby amended to read as follows: Bathrooms, water closet compartments and other similar rooms shall be provided with aggregate glazing area in windows of not less than 3 square feet (0.279 m2), one-half of which must be openable.

EXCEPTION: The glazed areas shall not be required where artificial light and a mechanical ventilation system are provided. The minimum ventilation rates shall be 50 cfm (23.6L/s) for intermittent ventilation or 20 cfm (9.4 L/s) for continuous ventilation. Ventilation air from the space shall be exhausted directly to the outside or to an attic ventilated in accordance with Section R806. The point of discharge of the exhaust air shall be at least 3 feet from any opening into the building. Bathrooms which contain only a water closet or lavatory, or combination thereof, and similar rooms, may be ventilated with an approved mechanical recirculating fan or similar device designed to remove odors from the air.

-States that bathroom exhaust can discharge into an attic area that is vented in accordance with this code.

7-905. - INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R303.4 MECHANICAL VENTILATION. Section R303.4 Mechanical Ventilation is hereby deleted.

-Removes the threshold for outdoor air into a home dwelling.

7-906. – INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R311.3.2 FLOOR ELEVATIONS FOR OTHER EXTERIOR DOORS. Section R311.3.2 Floor elevations for other exterior doors is hereby amended to read as follows: Doors other than the required egress door shall be provided with landings or floors not more than 7 ¾ inches (196 mm) below the top of the threshold.

EXCEPTION:

A landing is not required where a stairway of four or fewer risers is located on the exterior side of the door, provided the door does not swing over the stairway.

-Allows exterior doors other than the front door of a dwelling to have a maximum of four steps on the outside of the door instead of a landing.

7-907.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R311.7.8.5 GRIP SIZE. Section R311.7.8.5 is hereby amended to read as follows; All required handrails shall be of one of the following types or provide equivalent graspability.

1. Type I. Handrails with a circular cross section shall have an outside diameter of at least 1-1/4 inches (32mm) and not greater than 2 inches (51 mm). If the handrail is not circular it shall have a perimeter dimension of at least 4 inches (102 mm) and not greater than 6-1/4 inches (160 mm) with a maximum cross section of dimension of 2-1/4 inches (57 mm).

2. Type II. Handrails with a perimeter greater than 6-1/4 inches (160mm) shall provide a graspable finger recess area on both sides of the profile. The finger recess shall begin within a distance of 3/4 inch (19 mm) measured vertically from the tallest portion of the profile and achieve a depth of at least 5/16 inch (8mm) within 7/8 inch (22mm) below the widest portion of the profile. This required depth shall continue for at least 3/8 inch (10mm) to a level that is not less than 1-3/4 inches (45 mm) below the tallest portion of the profile. The minimum width of the handrail above the recess shall be 1-1/4 inches (32 mm) to a maximum of 2-3/4 inches (70mm). Edges shall have a minimum radius of 0.01 inches (0.25 mm).

EXCEPTION:

Handrails provided at other non-required exterior stairs may have a maximum horizontal cross-sectional dimension of 3-1/2 inches and shall be easily graspable.

-Allows for a 2X4 laid flat as a suitable handrail for a stairway on an exterior deck.

7-908. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R313 AUTOMATIC FIRE SPRINKLER SYSTEMS. Section R313 is hereby amended to read as follows: A builder of a one-and two family dwelling or townhouse shall offer to any purchaser, on or before the time of entering into the purchase contract the option, at the purchaser’s cost, to install or equip fire sprinklers in the one-and two-family dwelling or townhouse. Notwithstanding any other provision of law to the contrary, no purchaser of such one- and two family dwelling or townhouse shall be denied the right to install a fire sprinkler system in such dwelling or townhouse being purchased. The provisions of this section, which are intended to mirror the requirements of section RSMo 67.281, shall expire on December 31st, 2022.

-Amended to comply with state statute.

7-909. - INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R313.1 TOWNHOUSE AUTOMATIC FIRE SPRINKLER SYSTEMS. Section R313.1 Townhouse automatic fire sprinkler systems is hereby deleted.

-Amended to comply with state statute.

7-910. - INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R313.2 ONE- AND TWO FAMILY DWELLING AUTOMATIC FIRE SYSTEMS. Section R313.2 One- and two family dwellings automatic fire systems is hereby deleted.

-Amended to comply with state statute.

7-911. - INTERNATIONAL RESIDENTIAL CODE DELETED; R317.1.1 FIELD TREATMENT. Section R317.1.1 is hereby deleted.

-Deletes the requirement for field treatment of cut ends of treated lumber.

7-912. - INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R318.1.2 FIELD TREATMENT. Section R318.1.2 is hereby deleted.

-Deletes the requirement for field treatment of cut ends of treated lumber.

7-913. – INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R326 SWIMMING POOLS, SPAS AND HOT TUBS. Section 326 is hereby deleted.

-*Deletes the reference to the Swimming Pools, Spas and Hot Tubs code that is not currently adopted.*

7-914. - INTERNATIONAL RESIDENTIAL CODE ADDED; SECTION R401.3.1 MINIMUM STANDARDS. Section R401.3.1 is hereby added to read as follows: A. Minimum standards: All drainage facilities shall be designed to carry waters to the nearest drainage way, storm sewer conveyance, or other approved point of collection and conveyance. Erosion of ground in the area of discharge shall be prevented by installation of erosive control devices. Unless specified drainage ways and swales are specifically approved by the building official, abutting property lines between structures shall be designed to function as drainage ways. The toe of slopes shall set back from the property line a minimum of one foot. The area surrounding the building foundation shall have a drainage gradient as provided for in the International Residential Code, as amended from time to time with a draining gradient thereafter of not less than two percent toward approved drainage facilities unless waived by the building official.

B. Prohibited conduct: No person shall allow or cause any:

1) Obstruction to be created, installed or maintained within any drainage way, detention facility, or engineered swale which will create ponding on adjacent property, divert water onto the adjoining property, or impede drainage. Fences may be erected in such areas provided they do not unnecessarily restrict the flow of water.

2) Water from intermittent sources such as discharges from sump pumps, downspouts, foundation drains, swimming pools, swimming pool backwashes, or other similar sources excluding lawn sprinklers to be discharged closer than five feet to any adjoining property line.

C. Enforcement: Where such conditions exist and the code official has given written notice of the violation, the owner of the property shall take appropriate measures to eliminate the problems caused on the adjacent property, within the time period stated in the notice, and failure to do so shall be a violation of this chapter.

-Added storm water provisions that more clearly define acceptable discharge.

7-915. - INTERNATIONAL RESIDENTIAL CODE ADDED; SECTION R403.1.1.1 FOOTING REINFORCEMENT. Section R403.1.1.1 is hereby added to read as follows; Footings for basement foundation walls shall have a minimum reinforcement consisting of not less than two No. 4 bars, uniformly spaced, located a minimum of 3 inches clear from the bottom and edges of the footing.

-States a minimum standard for footing size and reinforcement.

7-916. - INTERNATIONAL RESIDENTIAL CODE ADDED. SECTION R403.1.1.2 COLUMN PADS. Section R403.1.1.2 is hereby added and reads as follows; Unless specified otherwise, column pads shall be a minimum of 24 inches by 24 inches and 8 inches deep (24” x 24” x 8”). Reinforcement shall consist of a minimum of three No. 4 bars each way, uniformly spaced, within each column pad.

-States a minimum standard for column pad size and reinforcement.

7-917. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R404.1.7 BACKFILL PLACEMENT. Section R404.1.7 is hereby amended to read as follows; Backfill shall not be placed against the wall until the wall has sufficient strength or has been sufficiently braced to prevent damage by the backfill.

EXCEPTION: Such bracing is not required for walls supporting less than 4 feet (1219 mm) of unbalanced backfill.

-States that a concrete foundation wall can be backfilled once it has cured to a sufficient strength.

7-918. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R405.2.3 DRAINAGE SYSTEM. Section R405.2.3 is hereby amended to read as follows: A sump shall be provided to drain the porous layer, footings, and foundations that retain earth and enclose habitable or usable space located below grade that do not drain and discharge by gravity to an approved storm sewer system or to daylight. The sump shall be at least 24 inches (610mm) in diameter or 20 inches square (0.0129 m2), shall extend at least 24 inches (610mm) below the bottom of the basement floor and shall be capable of positive gravity or mechanical drainage to remove any accumulated water. Sumps receiving storm water from any exposed exterior drain(s) or opening(s) shall be provided with back-up system(s) capable of assuring proper sump operation in case of power failure. The drainage system shall discharge into an approved storm sewer system or to daylight.

-Requires sump pumps that receive discharge from exterior daylight drains shall have a battery backup system installed.

7-919. - INTERNATIONAL RESIDENTIAL CODE ADDED; SECTION R506.2.5 INTERIOR UNDERSLAB DRAINS. Section R506.2.5 is hereby added to read as follows: Where foundations retain earth and enclose habitable or usable space located below grade, drains shall be provided below the floor slab. Drainage tiles, perforated pipe or other approved systems or materials shall be installed at or below the area(s) to be protected; shall be placed with positive or neutral slope to minimize the accumulation of deposits in the drainage system; and shall discharge by gravity or mechanical means to an approved storm water drainage system. The underslab drainage system shall be installed around the inner perimeter of the area(s) to be protected, or, in a manner that will provide adequate drainage for all area(s) to be protected and is approved by the building official. Interior underslab drains installed on uncompacted fill material shall be supported by mechanical means which are adequately tied into the concrete slab to ensure proper drainage throughout the underslab drain(s).

-Requires an interior drain tile under basement floor slabs to help prevent damage caused from hydrostatic pressure from ground water.

7-920. – INTERNATIONAL RESIDENTIAL CODE DELETED; SECTION R507.9.2 LATERAL CONNECTION. Section R507.9.2 is hereby deleted.

-Deleted the requirement and reference to a diagram of a device installed on exterior decks.

7-921. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R602.1 DRILLING AND NOTCHING OF THE TOP PLATE. Section R602.1 Drilling and notching of the top plate is amended to read as follows: When piping or ductwork is placed in or partly in an exterior wall or interior load bearing wall, necessitating cutting, drilling or notching of the top plate by more than 50 percent of its width, a galvanized metal tie not less than 0.054 inch thick (1.37 mm) (16 ga) and 1 ½ inches (38 mm) wide shall be fastened across and to the plate at each side of the opening with not less than four 10d (0.148 inch diameter) having a minimum length of 1 ½ inches (38 mm) at each side or equivalent. The metal tie must extend a minimum of 6 inches past the opening. See figure R602.6.1

EXCEPTION: When the entire side of a wall with the notch or cut is covered by wood structural panel sheathing.

-Reduces the amount of nails required on each side of the over notched top plate from 8 nails to 4.

7-922. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R801.3 ROOF DRAINAGE. Section R801.3 is hereby amended to read as follows: All dwellings shall have a controlled method of water disposal from roofs that will collect and discharge all roof drainage to the ground surface at least three (3) feet from foundation walls or to an approved drainage system.

-Requires downspout discharge a minimum of 3 feet from the foundation wall.

7-223. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R902.1. ROOF COVERING MATERIALS. Section R902.1 Roofing covering materials is hereby amended to read as follows: Roofs shall be covered with materials as set forth in Sections R904 and R905. Except where the code requires greater protection, roof coverings for new buildings or structures or additions thereto, or roof coverings utilized for re-roofing shall be a minimum of Class C. Class A, B or C roofing shall be installed in areas designated by law as requiring their use or when the edge of the roof is less than 3 feet (914 mm) from a property line. Classes A, B and C roofing required to be listed by this section shall be tested in accordance with UL 790 or ASTM E 108. Roof assemblies with coverings of brick, masonry, slate, clay or concrete roof tile, exposed concrete roof deck, ferrous or copper shingles or sheets, and metal sheets and shingles, shall be considered Class A roof coverings.

-Establishes a minimum roof covering material for flame spread.

7-924. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION R907.1 GENERAL. Section R907.1 is hereby amended to read as follows: Materials and methods of application used for re-covering or replacing an existing roof covering shall comply with the requirements of Chapter 9 as amended. Re-roofing includes any repairs of more than 10% of the total roof covering in any three year period. A repair of 10% or less of the total roof covering in any three year period may utilize approved roofing materials comparable to the existing roofing materials.

EXCEPTION: Re-roofing shall not be required to meet the minimum design slope requirement of one-quarter unit vertical in 12 units horizontal (2-percent slope) in Section R905 for roofs that provide positive roof drainage.

-Defines what is considered re-roofing.

7-925. - INTERNATIONAL RESIDENTIAL CODE DELETED; CHAPTER 11. Chapter 11 is hereby deleted.(See Article 8 of this chapter)

-Deletes the energy provisions of the IRC.

7-926. - INTERNATIONAL RESIDENTIAL CODE DELETED; CHAPTER 12. MECHANICAL ADMINISTRATION. Chapter 12 is hereby deleted. (See article 1 of this chapter)

7-927. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION M1501.1 OUTDOOR DISCHARGE. Section M1501.1 is hereby amended to read as follows: The air removed by every mechanical exhaust system shall be discharged to the outdoors. Air shall not be exhausted into an attic, soffit, ridge vent or crawl space.

EXCEPTIONS:

1.) Whole-house ventilation-type attic fans that discharge into the attic space of dwelling units having private attics shall be permitted.

2.) Bathroom exhaust fans installed in accordance with amended section R303.3.

--States that bathroom exhaust can discharge into an attic area that is vented in accordance with this code.

7-928. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION M1507.2 RECIRCULATION OF AIR. Section M1507.2 is hereby amended to read as follows: Exhaust air from bathrooms and toilet rooms shall not be recirculated within a residence or to another dwelling unit and shall be exhausted in accordance with amended section R303.3.

-States that bathroom exhaust can discharge into an attic area that is vented in accordance with this code.

7-929.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION G2414.5.2 COPPER TUBING. Section G2414.5.2 is hereby amended to read as follows: Copper tubing shall comply with standard Type K or L of ASTM B 88 or ASTM B 280. Copper and brass tubing shall not be utilized to distribute natural gas nor shall it be utilized to distribute any other fuel gas within a building or structure.

-States that copper tubing is prohibited material for distributing natural gas.

7-930. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION G2417.4.1 TEST PRESSURE. Section G2417.4.1 is hereby amended to read as follows; The test pressure to be used shall be not less than one and one-half times the proposed maximum working pressure, but not less than 10 psig (68.9kPa) irrespective of design pressure. For welded piping, and for piping carrying gas at pressures in excess of fourteen (14) inches water column pressure, the test pressure shall not be less than 60 psig. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe.

-States the minimum guidelines for testing a fuel gas system.

7-931. - INTERNATIONAL RESIDENTIAL CODE DELETED; CHAPTER 25. PLUMBING ADMINISTRATION. Chapter 25 is hereby deleted. (See Article 1 of this chapter)

7-932. - INTERNATIONAL RESIDENTIAL CODE ADDED; SECTION P2601.2.1 PROHIBITED DRAINAGE AND CONNECTIONS. Section P2601.2.1 is hereby added to read as follows: Sanitary sewer systems shall be designed, built and maintained in such a manner to prevent all storm or ground water from draining, discharging or entering into the sanitary sewer system. Connection of sump pumps, foundation drains, yard drains, gutter downspouts and any other storm water drainage receptacle(s) or system(s) are specifically prohibited from being connected to the sanitary sewer system.

-States prohibited connections to a sanitary sewer service system.

7-933. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P2603.5 FREEZING. Section P2603.5 is hereby amended to read as follows: Water, soil or waste pipe shall not be installed outside of a building, in exterior walls, in attics or crawl spaces, or in any other place subjected to freezing temperature unless adequate provision is made to protect it from freezing by insulation or heat or both. Water service pipe shall be installed not less than 42 inches in depth below grade.

-States the minimum burial depth for a water service line.

7-934. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P2603.5.1 SEWER DEPTH. Section P2603.5.1 is hereby amended to read as follows: Building sewers shall be a minimum of 12 inches below grade.

-States the minimum burial depth for a sanitary sewer service line.

7-935.- INTERNATIONAL RESIDENTIAL CODE ADDED; SECTION P2604.5 INSPECTION. Section P2604.5 is hereby added to read as follows: Excavations required for the installation of a building drainage system shall be open trench work and shall be kept open until the piping has been inspected and approved to cover.

-States guidelines for sanitary sewer service lines for visual inspection.

7-936.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P2902.5.3 LAWN IRRIGATION SYSTEMS. Section P2902.5.3 is hereby amended to read as follows: The potable water supply to lawn irrigation systems shall be protected against backflow by a device approved by the Missouri Department of Natural Resources. Backflow devices installed within structures shall be installed a minimum of 6 inches away from any wall or vertical obstruction. The backflow device shall be installed between 12 inches and 48 inches above the floor and shall be accessible.

-States the backflow device installed on lawn irrigation systems shall comply with Missouri Department of Natural Resources.

7-937.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P2902.6.2 PROTECTION OF BACKFLOW PREVENTERS. Section P2902.6.2 Protection of backflow preventers is hereby amended to read as follows: Backflow preventers shall not be located in areas subject to freezing except where they can be removed by means of unions, or are protected by heat, insulation or both.

EXCEPTION: In-ground backflow preventers installed for lawn irrigation systems.

-Allows backflow devices for irrigation systems to be installed at a depth less than the frost line.

7-938. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P3002.2 BUILDING SEWER. Section P3002.2 is hereby amended to read as follows: Building sewer piping shall be as shown in Table P3002.2. Forced main sewer piping shall conform to one of the standards for ABS plastic pipe, cast-iron pipe, copper or copper-alloy tubing, PVC plastic pipe, or pressure-rated pipe listed in Table P3002.2. In addition, building sewer piping shall be a minimum of schedule 40 PVC/ABS or equivalent unless otherwise approved by the building official.

-Establishes a minimum material for sewer service.

7-939.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P3005.4.2 BUILDING DRAIN AND SEWER SIZE AND SLOPE. Section P3005.4.2 is hereby amended to read as follows: Pipe sizes and slope shall be determined from Table P3005.4.2 on the basis of drainage load in fixture units (d.f.u.) computed from Table P3004.1. The minimum size of a building sewer serving a dwelling unit shall be four inches.

-Establishes a minimum size for building sewer service.

7-940.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION P3114.3 WHERE PERMITTED. Section P3114.3 is hereby amended to read as follows: Individual vents, branch vents, circuit vents and stack vents shall be permitted to terminate with a connection to an air admittance valve only when approved by the Administrative Authority.

-States air admittance valves are only approved to be installed when approved.

7-941. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION E3601.6.2 SERVICE DISCONNECT LOCATION. Section E3601.6.2 is hereby amended to read as follows: The service disconnecting means shall be installed at a readily accessible location either outside of a building or inside nearest the point of entrance of the service conductors. When service conductors are more than 10 feet in length from the point of entry to the service panel, a separate means of disconnect shall be installed at the service cable entrance to the building or structure. Service disconnecting means shall not be installed in bathrooms. Each occupant shall have access to the disconnect serving the dwelling unit in which they reside.

-States a maximum distance for a disconnect inside a building.

7-942.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION E3901.4.5 RECEPTACLE OUTLET LOCATION. Section E3901.4.5 Receptacle outlet location is hereby amended to read as follows: Receptacle outlets shall be located not more than 20 inches (508 mm) above the countertop or work surface. Receptacle outlet assemblies installed in countertops and work surfaces shall be listed for use in countertops or work surfaces. Receptacle outlets rendered not readily accessible by appliances fastened in place, appliance garages, sinks or rangetops as addressed in the exception to Section 3901.4.1, or appliances occupying dedicated space shall not be considered as these required outlets.

EXCEPTION: Receptacle outlets shall be permitted to be mounted not more than 12 inches (305 mm) below the countertop or work surface in construction designed for the physically impaired or for island and peninsular countertops or work surface where the surface is flat across its entire surface and the are no means to mount a receptacle within 20 inches (508 mm) above the countertop, such as in an overhead cabinet. Receptacles mounted below the countertop or work surface in accordance with this section shall not be located where the countertop or work surface extends more than 6 inches (152 mm) beyond its support base.

-Allows receptacles to be installed on the side of island countertops that do not have a backsplash.

7-943.- INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION E3902.2 GARAGE AND ACCESSORY BUILDING RECEPTACLES. Section E3902.2 Garage and accessory building receptacles is hereby amended to read as follows: All 125-volt, single-phase, 15- and 20- ampere receptacles installed in garages and grade level portions of unfinished accessory buildings used for storage or work areas shall have ground-fault circuit interrupter protection for personnel.

EXCEPTIONS:

1.) Receptacles that are not readily accessible such as a ceiling mounted receptacle for a garage door opener.

2.) A single receptacle supplied by a dedicated branch circuit that is located and identified for a specific use by a cord-and-plug-connected appliance such as a refrigerator, freezer or sump pump.

3.) A receptacle supplying only a permanently installed fire alarm or burglar alarm system.

-Allows for receptacles in garages that are dedicated for specific appliances to not be protected from ground-fault.

7-944. - INTERNATIONAL RESIDENTIAL CODE AMENDED; SECTION E3902.5 UNFINISHED BASEMENT RECEPTACLES. Section E3902.5 Unfinished basement receptacles is hereby amended to read as follows: All 125-volt, single phase, 15- and 20- ampere receptacles installed in unfinished basements shall have ground fault circuit interrupter protection for personnel. For the purposes of this section, unfinished basements are defined as portions or areas of the basement not intended as habitable rooms and limited to storage areas, work areas, and the like.

Exceptions:

1.) Receptacles that are not readily accessible such as a ceiling mounted receptacle for a garage door opener.

2.) A single receptacle supplied by a dedicated branch circuit that is located and identified for a specific use by a cord-and-plug-connected appliance such as a refrigerator, freezer or sump pump.

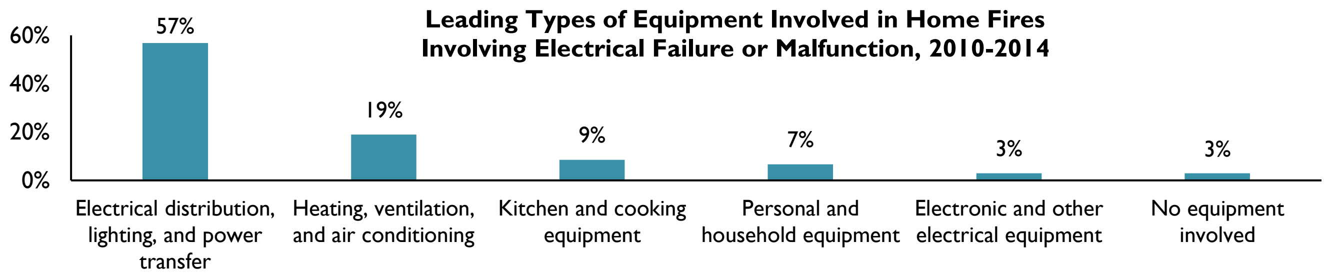
3.) A receptacle supplying only a permanently installed fire alarm or burglar alarm system.

-Allows for receptacles in garages that are dedicated for specific appliances to not be protected from ground-fault.

RESEARCH

ELECTRICAL FIRES FACT SHEET

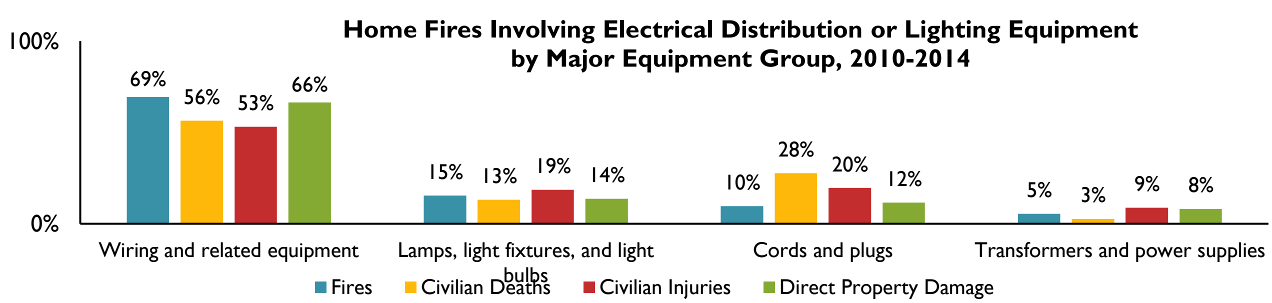
U.S. fire departments responded to an estimated annual average of 45,210 reported U.S. home structure fires involving electrical failure or malfunction in 2010-2014. These fires resulted in 420 civilian deaths, 1,370 civilian injuries and $1.4 billion in direct property damage each year. Some type of electrical failure or malfunction also contributed to the ignition of 16,070 *non-home* structure fires during this period, resulting in an estimated annual average of 12 civilian deaths, 210 civilian injuries, and $614 million in direct property damage.



Electrical distribution or lighting equipment was involved in 57% of the home fires involving electrical failure or malfunction. One-fifth (19%) of fires involved heating, ventilation and air conditioning equipment, 9% involved kitchen and cooking equipment, and 7% involved personal and household equipment.

Fires Involving Electrical Distribution or Lighting Equipment

U.S. fire departments responded to an estimated annual average of 31,960 reported non-confined home structure fires involving electrical distribution or lighting equipment in 2010-2014. These fires resulted in 400 civilian fire deaths, 1,180 civilian fire injuries, and $1.2 billion in direct damage. An estimated annual average of 14,760 non-confined *non-home* fires resulted in 20 civilian deaths, 190 civilian injuries, and $659 million in direct property damage each year over this period.



Wiring and related equipment accounted for the great majority of home fires and losses involving electrical distribution and lighting equipment (69% of fires, 56% of civilian deaths, 53% of civilian injuries, and 66% of direct property damage). Cords and plugs accounted for 10% of fires, but 28% of civilian deaths and 20% of civilian injuries, as well as 12% of direct property damage.

Source: NFPA, Research, Data & Analytics

NFPA, 1 Batterymarch Park, Quincy, MA 02169, www.nfpa.org
Contact information: 617-984-7451 or research@nfpa.org

Report
on
Structural Stability of Engineered Lumber in Fire Conditions

Project Number: 07CA42520
File Number: NC9140

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Executive Summary

This report describes the fire resistive performance of nine assemblies tested as part of a fire research and education grant sponsored by the Fire Prevention and Safety Grants under the direction of the Department of Home Security/Federal Emergency Management Agency/Assistance to Firefighters Grants.

Introduction

For over 35 years repeated concern has been expressed within the fire service community regarding the structural performance of wood "I" beams and 2 by 4 wood trusses commonly known as lightweight wood construction during a fire as compared to the former traditional construction of 2 by 10s supporting floors and 2 by 6s supporting roofs. In October 1992, the National Fire Protection Research Foundation published a report by Mr. Kirk Grundahl titled, "National Engineered Lightweight Construction Fire Research Project – Technical Report: Literature Search & Technical Analysis". The report citied 60 articles related to the fire performance of lightweight wood construction between 1970 and 1990. Conclusions of the research project included recognition of the need for fire performance data and the need for training focusing upon the fire performance of lightweight wood construction. These identified needs remain today.

The goals of this project include both the development of fire test data and the development of training methods. This report focuses only upon the development of the fire test data. The activities related to the educational material are reported separately.

Test Plan

Nine fire tests were conducted. Seven of the samples represented floor–ceiling constructions and two samples represented roof-ceiling constructions. A goal of the project was to develop comparable fire performance data among assemblies. All assemblies were intended to represent typical residential construction. Some assemblies included construction features such as 2 by 10 floor joists and 2 by 6 roof rafters that the fire service expressed satisfactory knowledge of their structural performance based upon their experience. Other assemblies included lighter weight wood structural members such as "I" joists and trusses. Two of the assemblies did not include a ceiling, six of the assemblies included a ceiling consisting of 1/2-inch thick regular gypsum board and one assembly included a 3/4-inch thick plaster ceiling.

The nine fire tests complied with the requirements of ASTM E119 but the applied structural load was non-traditional. Typically, a uniform load is applied on the floor or roof to fully stress the supporting structural members. This load is generally higher than the minimum design load of 40 psf specified by the building code for residential construction. For the tests described in this report, the load placed on the samples was intended to represent typical conditions during a fire. A load of 40 psf was placed along two of the four edges of the floor – ceiling assemblies to represent loads around a perimeter of a room. On each sample, two 300 pound concentrated loads were placed near the center of the sample. A mannequin, intended to simulate fire service personnel, represented each concentrated load. For the two samples that represented roof-ceiling assemblies, the two mannequins were the only live load applied on the test sample.

Standard ASTM E119, Fire Tests of Building and Construction Materials, describes a fire test method that establishes benchmark fire resistance performance between different types of building assemblies. For floor-ceiling and roof-ceiling assemblies, the standard requires a minimum 180 square foot sample prohibit the passage of flame through the sample and limit the temperature rise at specific locations as the sample while the sample supports a load and is exposed to a standardized fire. The standardized fire represents a fully developed fire within a residential or commercial structure with temperatures reaching 1000 ºF at 5 minutes and 1700 ºF at 60 minutes.

The construction details of the nine samples are summarized in Table E-1

Table E-1 - Summary of Test Samples

Test Assembly No.	Supports	Ceiling	Floor or Roof
1	2 by 10s @ 16 inch centers	None	1 by 6 subfloor & 1 by 4 finish floor
2	12 inch deep "I" joist @ 24 inch centers	None	23/32 inch OSB subfloor, carpet padding & carpet
3	2 by 10s @ 16 inch centers	1/2 inch regular gypsum wallboard	1 by 6 subfloor & 1 by 4 finish floor
4	12 inch deep "I" joist @ 24 inch centers	1/2 inch regular gypsum wallboard	23/32 inch OSB subfloor, carpet padding & carpet
5	Parallel chord truss with steel gusset plate connections, 14 inch deep @ 24 inch centers	1/2 inch regular gypsum wallboard	23/32 inch OSB subfloor, carpet padding & carpet
6	Parallel chord truss with glued connections, 14 inch deep @ 24 inch centers	1/2 inch regular gypsum wallboard	23/32 inch OSB subfloor, carpet padding & carpet
7	2 by 6s @ 16 inch centers with 2/12 pitch	1/2 inch regular gypsum wallboard	1 by 6 roof deck covered with asphalt shingles
8	2 by 10s @ 16 inch centers	3/4 inch plaster	1 by 6 subfloor & 1 by 4 finish floor
9	Roof truss with steel gusset plate	1/2 inch regular gypsum wallboard	7/16 inch OSB covered with asphalt shingles

Test Assembly No.	Supports	Ceiling	Floor or Roof
	connections @ 24 inch centers with 2/12 pitch		

Test Results

The results of the ASTM E119 fire tests are expressed in terms of hours such as 1/2 hour, 1 hour or 2 hour rated assemblies. These time ratings are not intended to convey the actual time a specific structure will withstand a fire. All fires are different. Variations result from room size, combustible content and ventilation conditions. The ASTM E119 test method does provide a benchmark that enables a comparison of fire performance between test samples.

For unrestrained floor-ceiling assemblies and unrestrained roof-ceiling assemblies such as the tested samples, ASTM E119 includes the following Conditions of Acceptance:

The sample shall support the applied load without developing conditions that would result in flaming of cotton waste place on the floor or roof surface.

Any temperature measured on the surface of the floor or roof shall not increase more than 325 ºF and the average temperature measured on the surface of the floor or roof shall not increase more than
250 ºF.

The results of the nine fire tests in terms of the ASTM E119 Conditions of Acceptance are summarized in Table E-2.

Table E-2 - Summary of Test Results ASTM E119

Test Assembly No.	Time of 250ºF avg. temperature rise on surface of floor / roof (min:sec)	Time of 325ºF max. temperature rise on surface of floor / roof (min:sec)	Flame passage through floor / roof (min:sec)	Collapse (min:sec)	Fire resistance rating (min)
1	*	*	18:30	18:45	19
2	*	*	06:00	06:03	6
3	*	*	44:15	44:45	44
4	*	*	*	26:45	27
5	*	29:15	28:40	29:15	29
6	*	24:15	26:00	26:45	24
7	39:45	38:30	26:00	40:00	26

Test Assembly No.	Time of 250ºF avg. temperature rise on surface of floor / roof (min:sec)	Time of 325ºF max. temperature rise on surface of floor / roof (min:sec)	Flame passage through floor / roof (min:sec)	Collapse (min:sec)	Fire resistance rating (min)
8	*	*	*	79:45	51**
9	*	*	*	23:15	23

Notes:
* - This condition was not achieved during the fire test.
** - Plaster ceiling in contact with furnace thermocouples at 51 minutes. The test method requires that the junction of the thermocouples in the furnace be placed 12 inches away from the ceiling surface at the beginning of the test and shall not touch the sample as a result of deflection.

In addition to the fire resistance rating determined by the Conditions of Acceptance in ASTM E119, a finish rating is typically published for fire resistive assemblies with combustible supports such as the tested as samples. The finished rating is defined as the time when the first occurrence of either: (1) a temperature measured on the face of the combustible supports nearest to the fire increases more than 325 ºF or (2) the average temperature measured on the face of the combustible supports nearest the fire increases more than 250 ºF.

Several fire test standards similar to ASTM E119 such as ISO 834:1 Fire-resistance tests – Elements of building construction – Part 1: General requirements define load bearing capacity as the elapsed time that a test sample is able to maintain its ability to support the applied load during the fire test. The ability to support the applied load is determined when both:

(1) Deflection exceeds: $\frac{L^2}{400d}$; and

(2) When the deflection exceeds $\frac{L}{30}$, the Rate of Deflection exceeds: $\frac{L^2}{9000d}$

where L is the clear span measured in millimeters and d is the distance from the extreme fiber of the design compression zone to the extreme fiber of the design tensile zone of the structural element as measured in millimeters.

Other significant data obtained during the fire tests included observation of the conditions of the ceiling and floor or roof surfaces, temperatures in the concealed space above the ceiling membrane and deflections of the floor and roof surfaces.

Other significant events that occurred during the nine fire tests are summarized in Table E-3

Table E-3 - Summary of Significant Events in Addition to ASTM E119 Conditions of Acceptance

Test Assembly No.	Initial falling of ceiling material (More than 1 ft^2) (min:sec)	Average temperature on unexposed surface of ceiling at initial falling (ºF)	Finish rating (min:sec)	Load bearing capacity (min)
1	No ceiling	No ceiling	00:45	18
2	No ceiling	No ceiling	00:30	4
3	23:30	605	15:30	45
4	17:15	531	7:45	25
5	16:30	519	10:45	24
6	16:00	559	12:15	25
7	15:45	253	15:15	40
8	74:00**	1109	74:00**	80
9	13:45	730	14:45	24

Notes:
** - plaster ceiling in contact with furnace thermocouples at 51 minutes

Research Findings

- The following summarizes the key findings documented in this report:

- The fire containment performance of a combustible floor-ceiling assembly representing typical legacy construction without a ceiling was 18 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This performance was defined as the bench mark performance for comparison purposes.

- The fire containment performance of a combustible floor-ceiling assembly supported by engineered I joists was 14 minutes less than the bench mark performance.

- The fire containment performance of the combustible floor-ceiling assembly supported by engineered I joists with a ½ inch thick regular gypsum board ceiling exceeded the benchmark performance by 7 minutes.

- The fire containment performance of a combustible floor-ceiling assembly supported by either: (1) engineered I joists, (2) parallel chord trusses with steel gusset plate connections or (3) parallel chord trusses with glued connections were approximately equal when a ceiling consisting of ½ inch thick regular gypsum wallboard was provided.

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General

This section describes the construction of the test assemblies, and the test results.

Test Assembly Materials

Several materials were used to construct more than one test assembly. The assemblies in which these materials were used are identified in Table 1.

Table 1 - Identification of Materials used in Multiple Assemblies

Material	Assembly Number								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Joists - 2 by 10	Yes	No	Yes	No	No	No	No	Yes	No
Engineered I Joist	No	Yes	No	Yes	No	No	No	No	No
Bearing Plates – 2 by 4	No	Yes	No	Yes	No	No	Yes	No	No
Bearing Plates - 2 by 6	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes
Subflooring (OSB)	No	Yes	No	Yes	Yes	Yes	No	No	No
Subflooring	Yes	No	Yes	No	No	No	No	Yes	No
Finished Flooring	Yes	No	Yes	No	No	No	No	Yes	No
Red Rosin Paper	Yes	No	Yes	No	No	No	No	Yes	No
Carpet with Padding	No	Yes	No	Yes	Yes	Yes	No	No	No
Tack Strip	No	Yes	No	Yes	Yes	Yes	No	No	No
Felt Paper - 30 lbs.	No	No	No	No	No	No	Yes	No	Yes
Class A Asphalt Shingles	No	No	No	No	No	No	Yes	No	Yes
Faced Batt Insulation	No	No	No	No	No	No	Yes	No	Yes
Gypsum Board - 1/2 in.	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes

The materials used in more than one assembly are described below.

Joists – The nominal 2 in. by 10 in. dimensional lumber measured 9-1/8 in. by 1-1/2 in. cut to a length of 13 ft 10 in. and bore the marking “SPF No. 2 KD-HT.” The moisture content of the joists ranged from 11.7 to 15.4 percent and averaged 13.3 percent moisture.

Engineered I Joists – The nominal 12 in. engineered I Joist measured 11-7/8 in tall and were cut to a length of 13 ft 7-3/4 in. The chords consisted of 2 in. wide by 1-3/16 deep laminated veneer lumber. The web consisted of 3/8 in. thick oriented strand board. The average weight of the I Joists was 34.94 lbs.

Bearing Plate (2 by 4) – The nominal 2 in. by 4 in. dimensional lumber measured 1-1/2 in. by 3-1/2 in. and cut to lengths of 5 ft 8 in. and 12 ft 3/4 in. long.

Bearing Plate (2 by 6) – The nominal 2 in. by 6 in. dimensional lumber measured 1-1/2 in. by 5-1/2 in. and cut to lengths of 9 ft 6 in. and 8 ft 3-1/2 in. long.

Subflooring (OSB) – The nominal 1 in. by 6 in. tongue and groove subflooring measured 3/4 in. by 5-1/8 in. and cut to random lengths.

Finish Flooring – The nominal 1 in. by 4 in. square edged finish floor measured 3/4 in. by 3-1/4 in. and cut to random lengths.

Red Rosin Paper – Measured 36 in. wide by 0.01 in. thick. The regular weight red rosin paper was supplied in a 144 ft. long roll.

Carpet Padding – The carpet padding measured 7/16 in. thick and was supplied in 6 ft wide by 45 ft long rolls. The carpet padding weighed 0.23 lbs/ft^2.

Carpet – The carpet was supplied in a 14 ft 3 in. wide by 18 ft. long roll. The nominal thickness of the carpet was 1/2 in. The carpet contained no identification markings. The carpet weighed 0.43 lbs/ft^2.

Tack Strip – Premium carpet gripper measured 1/4 in. thick by 7/8 in. wide and 48 in. long. The pre-nailed tack lengths were 3/4 in. and were spaced approximately 5-3/4 in. apart along the strip.

Gypsum Board – The nominal 1/2 in. thick regular gypsum wallboard had tapered edges and measured an average of 8 ft long by 4 ft wide and had an average thickness of 1/2 in. thick.

Felt Paper – No. 30 asphalt felt paper weighed 0.15 lb/ft^2 and was supplied in 216 ft^2 rolls. The rolls were 36 in. wide.

Class A Asphalt Shingles – Each shingle sheet measured 1 ft by 3 ft and weighed 2.66 lbs per sheet.

Faced Batt Insulation – The R-30 paper faced insulation measured 9-1/2 in. thick by 16 in. wide by 48 in. long. Each bundle weighed approximately 23.5 lbs.

Fire Endurance Test

The fire tests were conducted in accordance with the Standard, Fire Tests of Building Construction and Materials, ANSI/UL 263 (ASTM E119), 13th Edition, April 4, 2003.

Test Method

The standard test equipment of (UL) for floor/roof and ceiling assemblies was used for the fire endurance test.

The location of instrumentation within the furnace and on the test samples is shown in Appendix A. The furnace chamber temperatures were measured with 16 thermocouples located 12 in. below the exposed surface. A plot of the average furnace temperature verses the standard time temperature curve can be seen under the results portion of each test record.

During preparation of the test frames by UL prior to the construction of the test assembly, 4 in. by 6 in. by 3/4 in. thick steel angles were secured to the East and West edges of the test frames and set at depths specified in Table 2. The test frame was protected with vermiculite concrete poured to the top of the angles.

Table 2 - Set Depth of Steel Angles

Test Assembly Number	Angle Depth (Inch)
1	12-1/4
2	15
3	12-1/4
4	15
5	17
6	17
7	8-1/4
8	12-1/4
9	9

Assemblies 1-6 and 8 were loaded with a uniform load of 40 psf applied to the South and West edges of the assembly. The assembly was divided into quarters in the length and width and the loading was positioned over the Western and Southern quarters of the assembly. In addition to the uniform load, two 300 lb mannequins were located 24 inches North and South of the East-West centerline of the assembly, at the center of the span. One mannequin was intended to simulate a standing firefighter and the load was distributed over a four square foot base. The other mannequin was intended to simulate a crawling firefighter and the load was distributed through the hands and knees. Drawings showing the floor assembly loading are located in Appendix A.

Assemblies 7 and 9 were only loaded with the two 300 lb mannequins. The mannequins were located on the East half of the roof pitch at the center of the slope, 24 inches North and South of the East-West Centerline. Drawings showing the roof assembly loading are also located in Appendix A.

The deflection of each assembly after application of the load is shown in Table 3.

Table 3 - Deflection of Assembly After Application of Load

Test Assembly Number	Deflection (Inch)
1	0.13
2	0.25
3	0.10
4	0.09
5	0.07
6	0.08
7	Not Available
8	0.02
9	0.05

The floor ceiling and roof ceiling assemblies were installed in the test frame in accordance with standard practices and methods. The test assemblies were constructed by UL staff at UL's fire test laboratory located in Northbrook, IL.

All nine assemblies were tested in accordance with ASNI/UL263 and ASTM E119. The condition of acceptance for these standards state the transmission of heat thought the specimen during the classification period shall not have raised the average temperature on its unexposed surface to more than 250°F above its initial temperature. The specimen shall have sustained the applied load during the classification period without developing unexposed surface conditions that will ignite cotton waste.

Test Record No. 1

Materials

Materials described in section General and used in Assembly No. 1 include 2 in. by 10 in. joists, 2 in. by 6 in. bearing plates, subflooring, red rosin paper and finish flooring. Additional materials are described below.

Cross Bridging – The nominal 1 in. by 3 in. dimensional lumber measured 11/16 in. by 2-7/16 in. and each end was cut at an angle and a length of 16-3/8 in.

Erection of Test Assembly No. 1

Nominal 2 in. by 6 in. structural grade wood bearing plates were placed on top of the steel angles. The 2 in. by 10 in. joists were placed on the wood bearing plates and spaced 16 in. OC starting 8 in. from the East-West centerline of the assembly. The joists were fire stopped with 14-1/2 in. long pieces of nominal 2 by 10 in. lumber. At the North and South ends of the assembly, additional joists, not in the field of the fire for the test, were placed 2-1/2 inches from the North and South edges of the assembly over the vermiculite concrete in order stabilize the nominal 1 by 4 in. tongue and groove subfloor. The average bearing at each end of the joist was 5-1/4 in. The joists were fastened to each bearing plate with two No. 16d coated sinker nails.

The joists were stabilized by nominal 1 by 3 in. bridging cut to lengths of approximately 16-1/2 in. long with their ends cut to an angle of approximately 45 degrees. The pieces of bridging was secured diagonally opposed to each other between each pair of joists with two 8d coated sinker nails at each end of each piece.

The nominal 1 by 6 in. random length tongue and groove subfloor boards were laid diagonally (45 degrees to the joists) and secured in place with No. 8d coated sinker nails four nails per butt joint and two nails in the field at each joist.

The red rosin paper was laid over the subfloor in the East-West direction and secured in place with staples in a random order. There was a 4 in. overlap of each roll of paper.

The nominal 1 by 4 in. tongue and groove finish floor was installed over the building paper and oriented perpendicular to the joists. The finish floor was secured to the joists by 2 in. FLN-200 hardwood flooring nails spaced nominally 8 in. OC nailed through the tongue and groove using an angled flooring nailer.

A bead of fire resistive caulk was placed around the perimeter of the assembly to prevent any flame through between the frame and the test sample.

Test Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Test Method

The location of instrumentation within the furnace and on the test sample is shown on Figures A1.1 - A1.8 in Appendix A.

The temperatures of the nominal 2 by 10 in joists were measured with 20 thermocouples. Thermocouple numbers 16-25 were located on the bottom of joist and thermocouple numbers 26-35 were located on the side of the joist mid depth facing North. The thermocouples were stapled to the joists.

The temperatures within the interstitial space were measured with 18 thermocouples. Thermocouple numbers 36-44 were located at the center of the interstitial space mid depth, and thermocouple numbers 45-53 located at the center of the interstitial space on the bottom of the subfloor.

The temperatures between the subfloor and finish floor were measured with 15 thermocouples and numbered 1-15.

The temperatures on the unexposed surface were measured with 15 thermocouples and numbered 54-68. Each of the unexposed surface thermocouples was covered with a 6 by 6 in. dry ceramic fiber pad.

The deflection of the assembly was measured with five electronic transducers.

There were a total of eight camera views taken during the fire exposure period. One camera was positioned in the furnace recording the exposed surface of the assembly. Five other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 1.

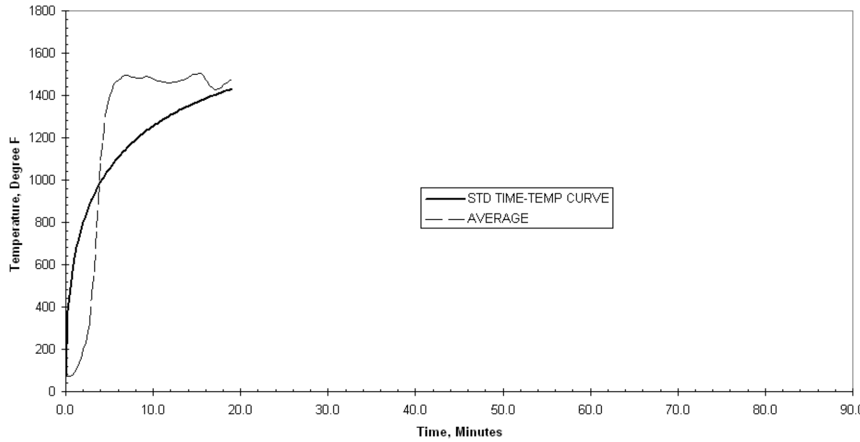


Figure 1 - UL263 Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Assembly No. 1

Observations of the Exposed and Unexposed Surfaces - The observations were made during the fire test are presented in Table 4. All references to dimensions are approximate.

Table 4 – Observations for Test Assembly No. 1

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
1:00	E	Bottom of 2 by 10 in. joists began to char.
1:41	E	The 2 by 10 in. joists ignited.
2:05	E	The 1 by 6 in. subfloor ignited.
2:30	E	Visible observations were obscured by smoke.
2:30	U	Cracking from burning joists and subfloor could be heard.
3:00	E	Intense flaming and shaking of the assembly for about 10 seconds.
3:00	U	Microphone on standing firefighter was vibrating.
5:00	E	Still no visible observations could be seen due to excessive flames and smoke.
8:00	E	Only the furnace TCs and pylons could be seen.
9:50	E	Thought the heavy smoke and flames, sparks can be seen falling from the assembly.
13:45	U	Smoke began to emit from the joints in the hardwood floor.
18:30	U	Flame through occurred near crawling mannequin.
18:45	E	Mannequins fell through the floor assembly. Gas off.

Temperatures of the Wood Joists - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom surface nearest the fire 250°F or the time required to raise the temperature on the bottom surface 325°F at any point. The average temperature measured on the bottom surface of the joists was 73°F before the test. Therefore, the average limiting temperature was 323°F and the individual limiting temperature was 398°F. The average limiting temperature for the finish rating was reach at 45 seconds as recorded by the average of thermocouple numbers 16-25.

Temperatures of the Side of Mid Depth of Wood Joists – The average and maximum temperatures of the sides of the wood joists just before the moment of collapse (18 min 45 sec) were 1110°F and 1158°F respectively. The maximum individual temperature was recorded by thermocouple number 28. The average temperature was plotted on Figure 1.2.

Temperatures of the Mid Depth Between Wood Joists – The average and maximum temperatures of the mid depth between the wood joists just before the moment of collapse (18 min 45 sec) were 1114°F and 1147°F respectively. The maximum individual temperature was recorded by thermocouple number 38. The average temperature was plotted on Figure 1.2.

Temperatures of the Sub Floor Between Wood Joists – The average and maximum temperatures of the sub floor between the wood joists just before the moment of collapse (18 min 45 sec) were 1122°F and 1161°F respectively. The maximum individual temperature was recorded by thermocouple number 46. The average temperature was plotted on Figure 2.

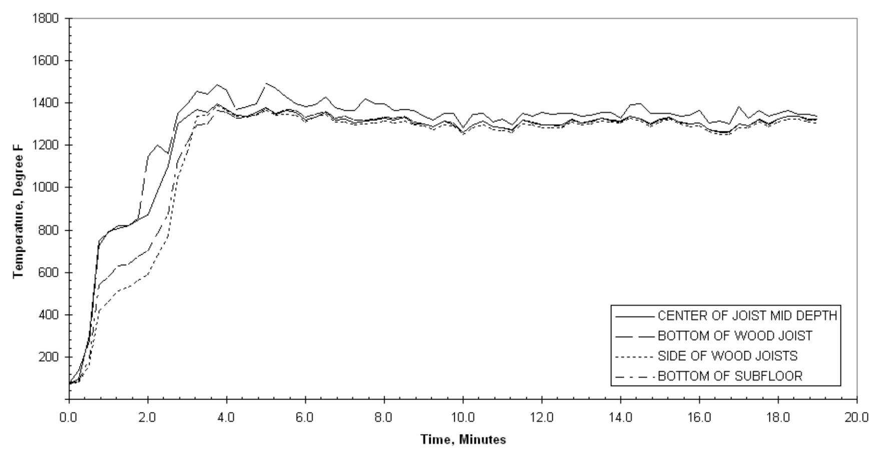


Figure 2 - Plot of Temperatures Below Subfloor vs. Time for Assembly No. 1

Temperatures of Between the Sub Floor and Finish Floor – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (18 min 45 sec) were 383°F and 939°F respectively. The maximum individual temperature was recorded by thermocouple number 8. The average temperature was plotted on Figure 3.

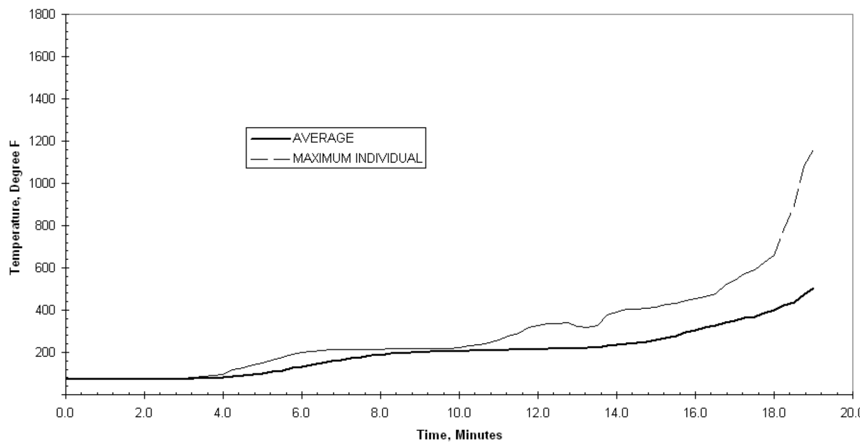


Figure 3 - Plot of the Subfloor Temperatures vs. Time for Assembly No. 1

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (18 min 45 sec) were 122°F and 616°F respectively. The maximum individual temperature was recorded by thermocouple number 61. The average temperature and maximum temperatures were plotted on Figure 4.

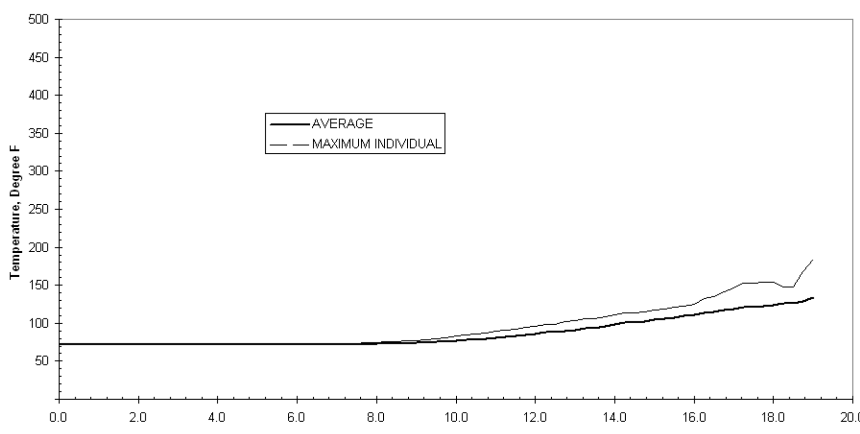


Figure 4 - Plot of the Unexposed Surface Temperatures vs. Time for Assembly No. 1

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 5. The location of each deflection transducer can be seen in Appendix A under Test Assembly 1.

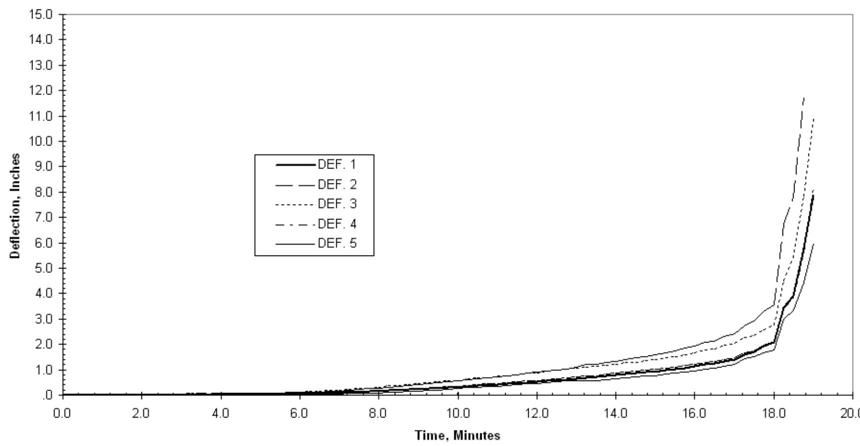


Figure 5 - Plot of Deflections vs. Time for Assembly No. 1

Test Record No. 2

Materials

Materials described in section General and used in Assembly No. 2 include engineered I Joist, 2 by 4 bearing plate, subfloor (OSB), carpet and padding, and tack strips. Additional materials are described below.

Rimboard – The nominal 1-1/8 in. by 12 in. OSB measured 1-1/8 in. thick by 11-15/16 in. wide and 144 in.

Erection of Test Assembly

Nominal 2 in. by 4 in. structural grade wood bearing plates were placed on top of the steel angles. The wood I joists were placed on the wood bearing plates and spaced 24 in. OC starting at the East-West centerline of the assembly. The joists were fire stopped with 12 ft long pieces of rimboard. At the North and South ends of the assembly, two additional wood I joists, not in the field of the fire for the test, were placed on the North and South edges of the assembly over the vermiculite concrete, of the laboratory’s test frame, in order stabilize the wood tongue and groove subfloor. The average bearing at each end of the truss was 2-1/4 in. The trusses were fastened to each bearing plate with two No. 8d coated sinker nails spaced 12 in. OC.

The nominal 8 ft by 4 ft tongue and groove subfloor boards were laid perpendicular to the wood I joists. A 1/4 in. bead of adhesive was placed on the top flange of each wood I joist and a 1/8 in. bead of adhesive was placed on the tip of the tongue and groove connection prior to sliding the subfloor panels together and set in place. The subfloor panels were secured in place with 1-7/8 in. long ringshank underlayment nails spaced 6 in. OC at the edges of the panels and 12 in. OC in the field of each panel.

The pre-nailed tack strips were secured to the subfloor around the perimeter of the assembly approximately 2 in. from the inside edge of the test frame.

The 6 ft wide carpet padding had joints spaced 6 ft, 12 ft and 17 ft 6 in starting at the South edge of the assembly. The carpet padding was secured to the subfloor with 1/4 in. long staples spaced 18 in. OC around the perimeter of each laid piece of padding.

The 14 ft 3 in. wide by 18 ft long roll of carpet was laid on top of the carpet padding. The carpet was stretched tight and secured to the carpet gripper nailing strips located at the perimeter of the entire assembly.

Test Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The location of instrumentation within the furnace and on the test sample is shown on Figures A1.1 - A1.8 in Appendix A.

The temperatures of the wood I joists were measured with 20 thermocouples. Thermocouple numbers 31-40 were located on the bottom of I joist and thermocouple numbers 41-50 were located on the side of joist at mid depth facing North and stapled to the trusses.

The temperatures within the interstitial space were measured with 20 thermocouples. Thermocouple numbers 51-60 were located at the center of the interstitial space mid depth and thermocouple numbers 61-70 were located at the center of the interstitial space on the bottom of the subfloor.

The temperatures between the subfloor and carpet padding were measured with 15 thermocouples and numbered 1-15.

The temperatures on top of the carpet padding (between the carpet padding and carpet) were measured with 15 thermocouples and numbered 16-30.

The unexposed temperature were measured with 13 thermocouples and numbered 71-83. Each of the unexposed surface thermocouples was covered with a 6 by 6 in. dry ceramic fiber pad.

The deflection of the assembly was measured with five electronic transducers.

There were a total of eight camera views taken during the fire exposure period. One camera was positioned in the furnace recording the exposed surface of the assembly. Six other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 6.

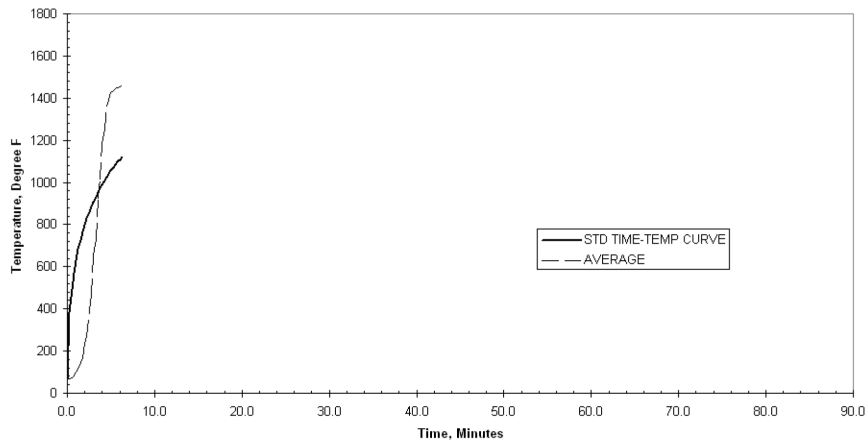


Figure 6 – UL263 Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Assembly No. 2

The furnace pressure and oxygen concentration measured in the furnace are presented in Figure 7and Figure 8.

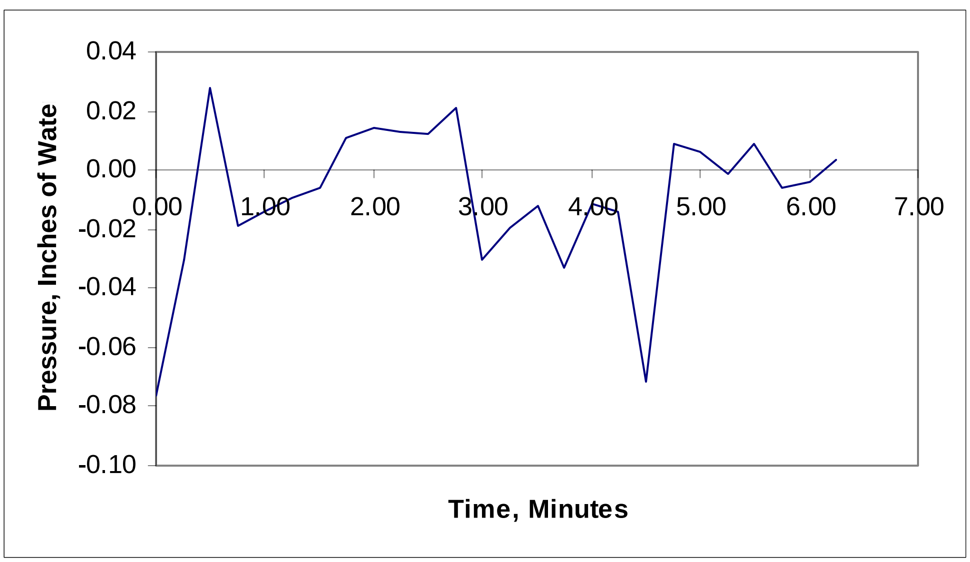


Figure 7 - Furnace Pressure vs. Time for Assembly No. 2

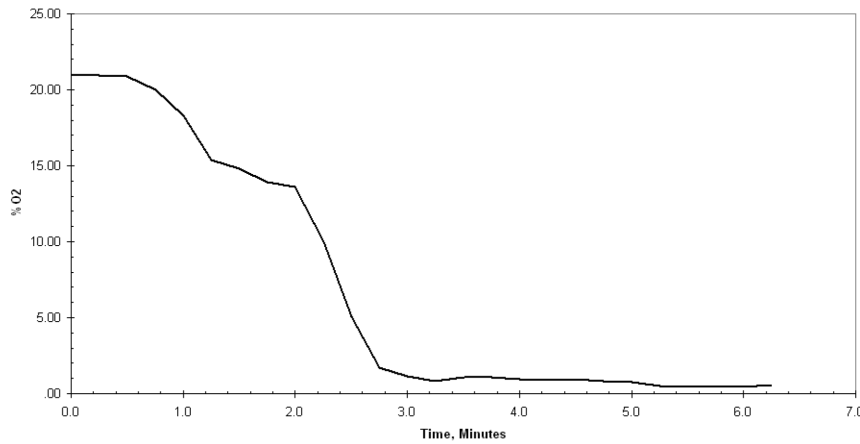


Figure 8 - Oxygen Content vs. Time Oxygen Content vs. Time for Assembly No. 2

Observations of the Exposed and Unexposed Surfaces - The following observations were made during the fire test. All references to dimensions are approximate.

Table 5 – Observations for Assembly No. 2

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
0:55	E	Wood members began to char.
1:00	U	No change.
1:25	E	All wood ignited.
2:00	E	All member completely engulfed in flames.
2:00	U	Smoke emitting from perimeter and smoke emitted from long plywood joints.
2:30	E	Vibrations could be felt and the furnace was sucking air from below.
2:35	U	Floor vibrating up and down.
3:15	U	Vibration continued.
3:30	E	Sucking of air continued.
4:00	U	Vibration continued and noticeable deflection about 6 inches.
4:30	U	Vibration stopped.
5:00	U	Crackling could be heard and deflection about 1-1.5 ft.
6:00	U	Flame through at South West corner of assembly.
6:03	U	Gas Off
6:03	E	Floor collapsed. Gas Off

Temperatures of the Wood I Joists - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom chords nearest the fire 250°F or the time required to raise the temperature on the bottom chords 325°F at any point. The average temperature measured on the bottom chords of the trusses was 73°F before the test. Therefore, the average limiting temperature was 323°F and the individual limiting temperature was 398°F.

The individual limiting temperature for the finish rating was reach at 30 seconds as recorded by thermocouple number 39.

Temperatures on the Side of Mid Depth of the Wood I Joists – The average and maximum temperatures of the sides of the wood joists just before the moment of collapse (6 min 3 sec) were 1362°F and 1486°F respectively. The individual temperature was recorded by thermocouple number 45. A plot of these temperatures can be seen on Figure 9.

Temperatures of the Mid Depth Between Wood Joists – The average and maximum temperatures of the mid depth between the wood joists just before the moment of collapse (6 min 3 sec) were 1377°F and 1430°F respectively. The individual temperature was recorded by thermocouple number 58. A plot of these temperatures can be seen on Figure 9.

Temperatures of the Sub Floor Between Wood Joists **–** The average and maximum temperatures of the sub floor between the wood joists just before the moment of collapse (6 min 3 sec) were 1361°F and 1417°F respectively. The individual temperature was recorded by thermocouple number 70. A plot of these temperatures can be seen on Figure 9.

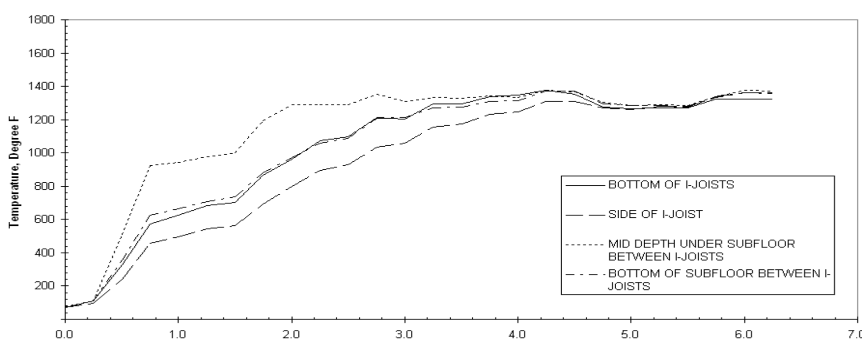


Figure 9 - Plot of Temperatures Below Subfloor vs. Time for Assembly No. 2

Temperatures of Between the Sub Floor and Carpet Padding – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (6 min 3 sec) were 228°F and 1371°F respectively. The individual temperature was recorded by thermocouple number 3. A plot of these temperatures can be seen on Figure 10.

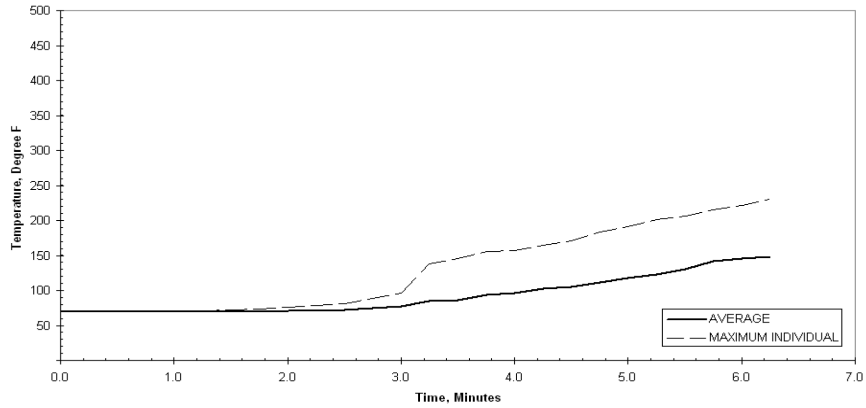


Figure 10 - Plot of the Subfloor Temperatures vs. Time for Assembly No. 2

Temperatures of Between the Carpet Padding and Carpet – The average and maximum temperatures between the carpet padding and carpet just before the moment of collapse (6 min 3 sec) were 109°F and 187°F respectively. The individual temperature was recorded by thermocouple number 29. A plot of these temperatures can be seen on Figure 11.

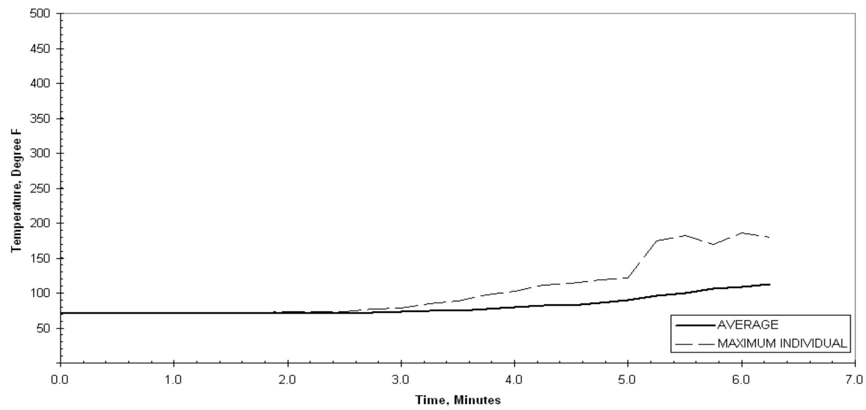


Figure 11 - Plot of Temperature of the Carpet Padding vs. Time for Assembly No. 2

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (6 min 3 sec) were 90°F and

114°F respectively. The individual temperature was recorded by thermocouple number 83. A plot of these temperatures can be seen on Figure 12.

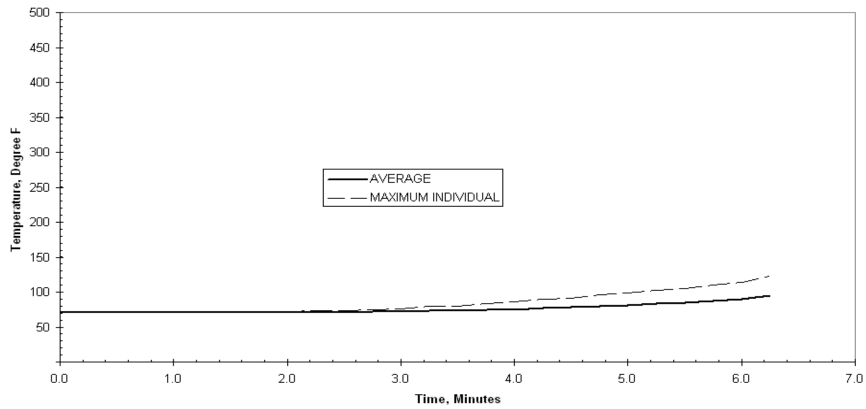


Figure 12 - Plot of Unexposed Surface Temperatures vs. Time for Assembly No. 2

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 13. The location of each deflection transducer can be seen in Appendix A under Test Assembly 2.

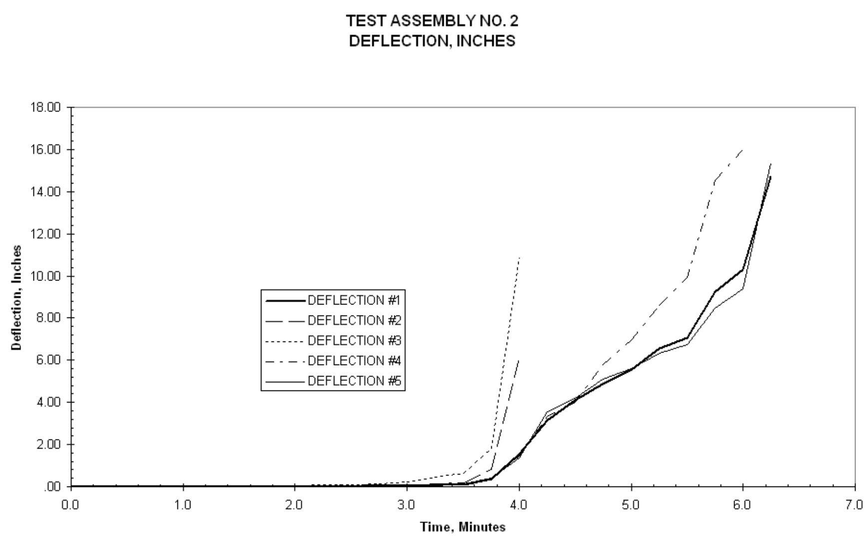


Figure 13 - Plot of Deflections vs. Time for Assembly No. 2

Test Record No. 3

Materials

Materials described in Section General and used in Assembly No. 3 include 2 in. by 10 in. joists, 2 in. by 6 in. bearing plates, subflooring, red rosin paper, finish flooring, and 1/2 in. gypsum board. Additional materials are described below.

Cross Bridging – The nominal 1 in. by 3 in. dimensional lumber measured 11/16 in. by 2-7/16 in. and each end was cut at an angle and a length of 16-3/8 in.

Erection of Test Assembly

Nominal 2 in. by 6 in. structural grade wood bearing plates were placed on top of the steel angles. The 2 in. by 10 in. joists were placed on the wood bearing plates and spaced 16 in. OC starting 8 in. from the East-West centerline of the assembly. The joists were fire stopped with 14-1/2 in. long pieces of nominal 2 by 10 in. lumber. At the North and South ends of the assembly, additional joists, not in the field of the fire for the test, were placed 2-1/2 inches from the North and South edges of the assembly over the vermiculite concrete in order stabilize the nominal 1 by 4 in. tongue and groove subfloor. The average bearing at each end of the joist was 5-1/4 in. The joists were fastened to each bearing plate with two No. 16d coated sinker nails.

The joists were stabilized by nominal 1 by 3 in. bridging cut to lengths of approximately 16-1/2 in. long with their ends cut to an angle of approximately 45 degrees. The pieces of bridging was secured diagonally opposed to each other between each pair of joists with two 6d coated sinker nails at each end of each piece.

The nominal 1 by 6 in. random length tongue and groove subfloor boards were laid diagonally (45 degrees to the joists) and secured in place with No. 8d coated sinker nails four nails per butt joint and two nails in the field at each joist.

The red rosin paper was laid over the subfloor in the East-West direction and secured in place with staples in a random order. There was a 4 in. overlap of each roll of paper.

The nominal 1 by 4 in. tongue and groove finish floor was installed over the building paper and oriented perpendicular to the joists. The finish floor was secured to the joists by 2 in. FLN-200 hardwood flooring nails spaced nominally 8 in. OC nailed through the tongue and groove using an angled flooring nailer.

A bead of fire resistive caulk was placed around the perimeter of the assembly to prevent any flame through between the frame and the test sample.

The gypsum board was secured to the exposed side of the assembly with 1-5/8 in. long phosphate coated drywall nails spaced 7 in. OC with nails spaced 1 in from the edge in the field and at the perimeter. The East-West gypsum board joints were staggered 4 ft as to not align any East-West joints. The North-South gypsum board joints were aligned and spaced 4 ft OC. The long edges of the boards were oriented perpendicular to the joists. Two layers of dry mix joint compound was used to cover all gypsum board joints and nails heads.

Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The location of instrumentation within the furnace and on the test sample is shown in Appendix A.

The temperatures of the nominal 2 by 10 in joists were measured with 20 thermocouples. Thermocouple numbers 16-25 were located on the bottom of the joists and thermocouple numbers 26-35 were located on the side of joist mid depth facing North and stapled to the joists.

The temperatures within the interstitial space were measured with 18 thermocouples. Thermocouple numbers 45-53 were located at the center of the interstitial space mid depth and thermocouple numbers 54-62 were located at the center of the interstitial space on the bottom of the sub floor.

The temperatures between the subfloor and finish floor were measured with 15 thermocouples and numbered 1-15.

The temperatures on the unexposed side of the gypsum board were measured with 9 thermocouples and numbered 36-44.

The temperatures on the unexposed surface were measured with 15 thermocouples and numbered 63-77. Thermocouple number 72 malfunctioned and did not record any data. Each of the unexposed surface thermocouples was covered with a 6 by 6 in. dry ceramic fiber pad.

The deflection of the assembly was measured with five electronic transducers.

There were a total of eight camera views taken during the fire exposure period. Two cameras were positioned in the interstitial spaced in the cavities under both the kneeling and standing mannequins, both cameras were facing West. One camera was positioned in the furnace recording the exposed surface of the assembly, one infrared camera recording the unexposed surface temperatures. Four other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 14.

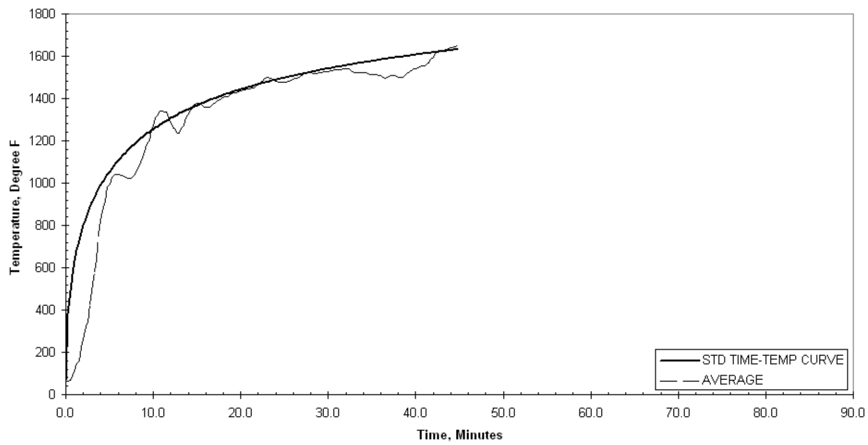


Figure 14 - UL263 Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Test Assembly No. 3

The furnace pressure and oxygen concentration during the test are presented in Figure 15 and Figure 16.

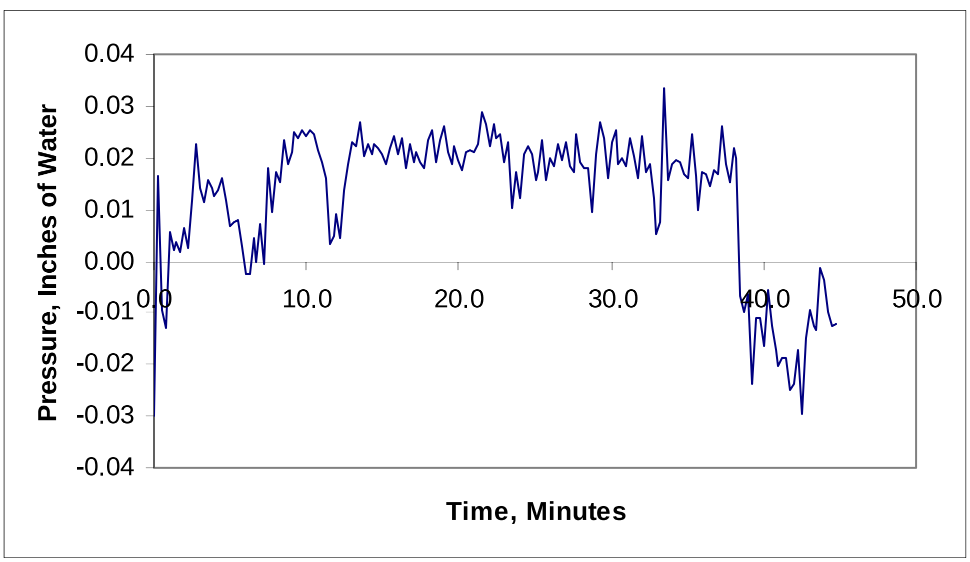


Figure 15 - Furnace Pressure vs. Time for Test Assembly No. 3

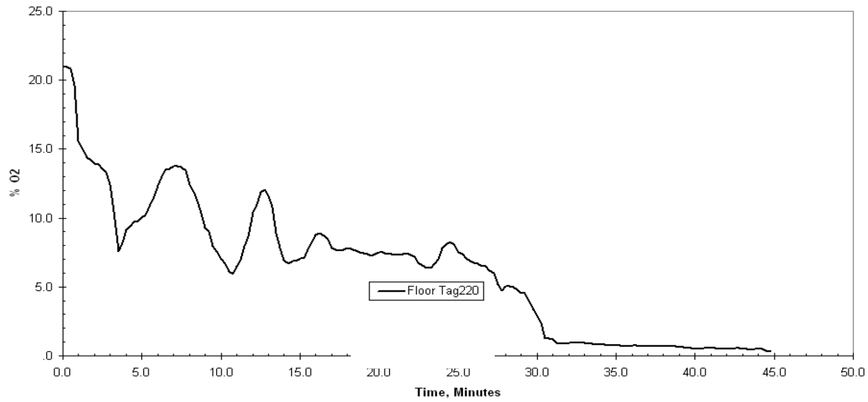


Figure 16 - Oxygen Content vs. Time for Test Assembly No. 3

Observations of the Exposed and Unexposed Surfaces - The observations made during the fire test are presented in Table 6. All references to dimensions are approximate.

Table 6 - Observations for Test Assembly No. 3

Test Time (Min:Sec)	Exposed (E) or Unexposed (U) Surface	Observations
4:00	E	Entire surface black in color.
4:00	U	No Change.
4:30	E	A very small piece of joint compound fell from a butt joint near the center of the assembly.
6:00	U	No Change.
7:00	E	Additional small areas of joint compound fell from the butt joints.
8:00	U	No Change.
10:00	E	Joint tape and compound fell from long joints.
10:00	U	No Change.
12:00	U	No Change.
12:45	E	Tape and compound continued to fall from joints and stated to fall from nail heads.
14:00	E	Surface turned gray/white in color.
14:00	U	No Change.
16:00	U	No Change.

Test Time (Min:Sec)	Exposed (E) or Unexposed (U) Surface	Observations
16:30	U	Smoke emitting from perimeter at SE corner.
18:00	E	A long crack in the field of one board near the center of the assembly, 2 from South end occurred.
19:00	U	No Change.
21:00	E	Additional large crack in board near center of the assembly 10 ft from North edge of assembly occurred.
21:00	U	Smoke emitting form all saddle locations.
23:00	E	Additional large cracks opening randomly in gypsum board.
23:00	U	No Change.
23:30	E	2 ft by 4 ft piece of gypsum board fell.
23:30	U	Crackling could be heard.
24:45:00	E	1 ft by 1 ft piece of gypsum board fell.
26:00:00	E	No Change.
26:15:00	E	1 ft by 2 ft piece of gypsum board fell from south edge.
26:45:00	E	Cracking noises heard.
27:30:00	E	Additional pieces of gypsum board fell randomly.
28:00:00	U	Crackling could be heard and more intense smoke could be seen.
28:15:00	E	No visual observations could be made.
28:45:00	U	Smoke Coming through butt joints of oak flooring North Center.
30:30:00	U	Smoke coming through butt joints of oak flooring East Center.
33:00:00	U	Smoke emitting through butt joints of entire assembly.

Test Time (Min:Sec)	Exposed (E) or Unexposed (U) Surface	Observations
34:00:00	U	Crackling continued and smoke increased.
35:30:00	E	No change, still no visual observations could be made.
37:00:00	U	Smoke continued to increase
39:00:00	U	Smoke almost non-existent.
41:00:00	U	Smoke at perimeter and at floor butt joints.
41:15:00	U	Smoke emitting from pant leg of kneeling mannequin.
42:30:00	U	Pop heard. Buckling of finish flooring between concrete weight and mannequins.
44:00:00	U	Significant smoke at feet of standing mannequin.
44:15:00	U	Flame through at base of standing mannequin.
44:45:00	U	Standing mannequin fell through. Gas off.
44:45:00	E	Mannequin fell through. Gas off.

Temperatures of the Wood Joists - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom surface nearest the fire 250°F or the time required to raise the temperature on the bottom surface 325°F at any point. The average temperature measured on the bottom surface of the joists was 63°F before the test. Therefore, the average limiting temperature was 313°F and the individual limiting temperature was 388°F. The limiting temperature for the finish rating was reach at 15 minutes and 30 seconds as recorded by both the average of thermocouple numbers 16-25 and the individual thermocouple number 21.

Temperatures of the Side of Mid Depth of Wood Joists – The average and maximum temperatures of the sides of the wood joists just before the moment of collapse (44 min 45 sec) were 1450°F and 1550°F respectively. The individual temperature was recorded by thermocouple number 33. A plot of these temperatures can be seen on Figure 17.

Temperatures of the Mid Depth Between Wood Joists – The average and maximum temperatures of the mid depth between the wood joists just before the moment of collapse (44 min 45 sec) were 1482°F and 1566°F respectively. The individual temperature was recorded by thermocouple number 52. A plot of these temperatures can be seen on Figure 17.

Temperatures of the Sub Floor Between Wood Joists – The average and maximum temperatures of the sub floor between the wood joists just before the moment of collapse (44 min 45 sec) were 1467°F and 1528°F respectively. The individual temperature was recorded by thermocouple number 62. A plot of these temperatures can be seen on Figure 17.

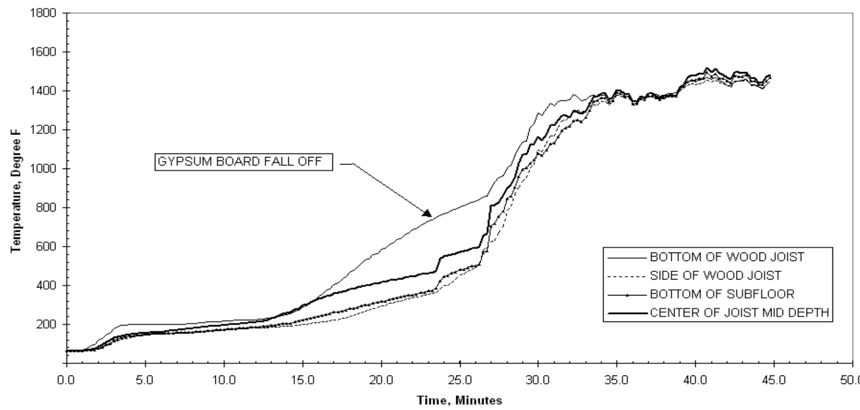


Figure 17 - Plot of Temperature Below Subfloor vs. Time for Assembly No. 3

Temperatures of the Unexposed Side of Gypsum Board - The average and maximum temperatures of the unexposed surface just before the moment of gypsum board fall off (23 min 30 sec) were 605°F and 617°F respectively. The individual temperature was recorded by thermocouple number 41. A plot of these temperatures can be seen on Figure 18.

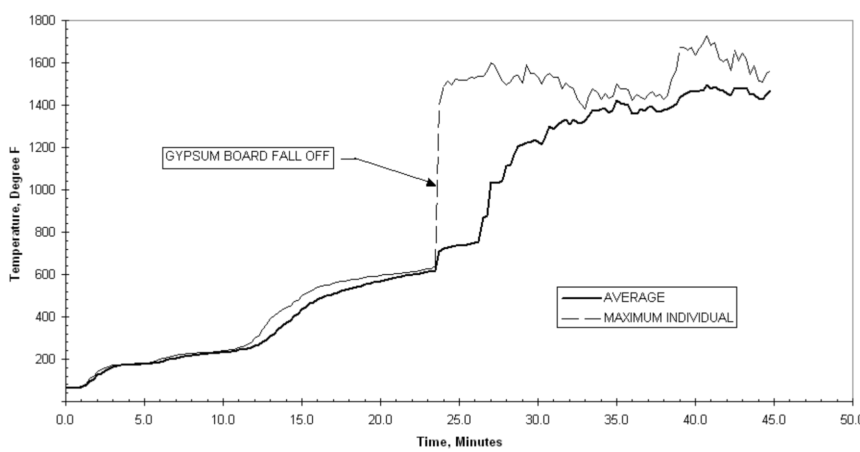


Figure 18 - Plot of Temperature of the Unexposed Surface of Gypsum Board vs. Time for Assembly No. 3

Temperatures of Between the Sub Floor and Finish Floor – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (44 min 45 sec) were 993°F and 1479°F respectively. The individual temperature was recorded by thermocouple number 6. A plot of these temperatures can be seen on Figure 19.

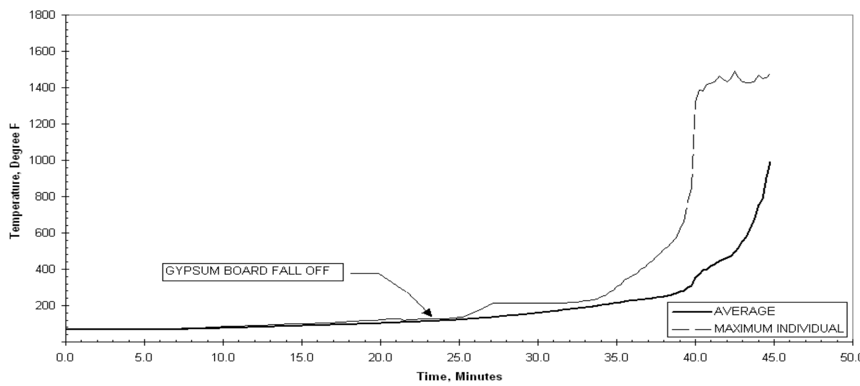


Figure 19 - Plot of Temperature of the Subfloor Temperatures vs. Time for Assembly No. 3

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (44 min 45 sec) were 152°F and 183°F respectively. The individual temperature was recorded by thermocouple number 77. A plot of these temperatures can be seen on Figure 20.

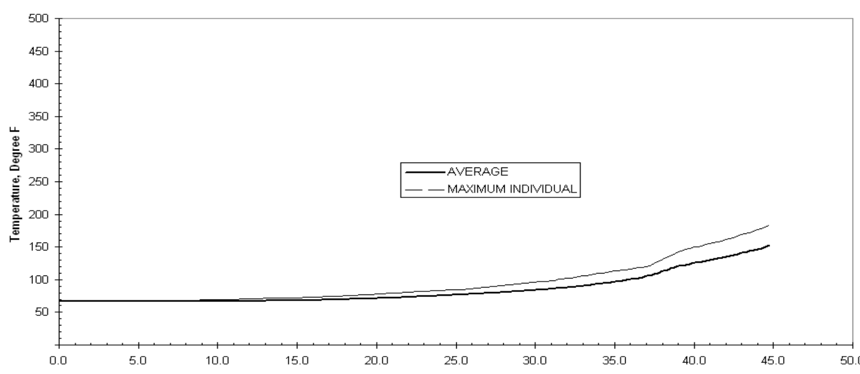


Figure 20 - Plot of Temperatures of the Unexposed Surface vs. Time for Assembly No. 3

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 21. The location of each deflection transducer can be seen in Appendix A under Test Assembly 3.

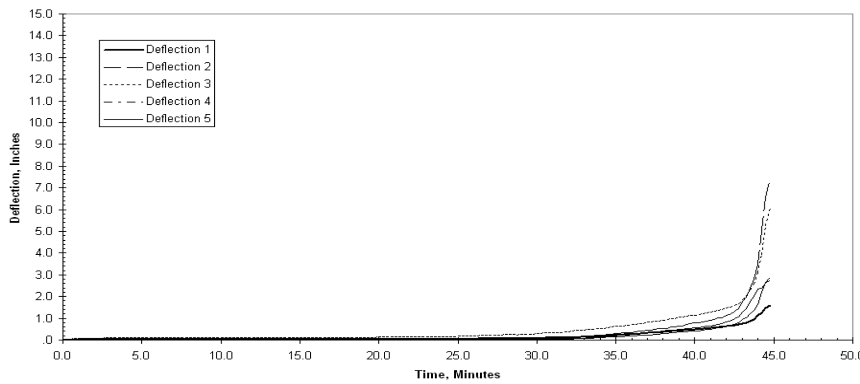


Figure 21 - Plot of Deflections vs. Time for Assembly No. 3

Test Record No. 4

Materials

Materials described in section General and used in Assembly No. 4 include engineered I Joist, 2 by 4 bearing plate, subfloor (OSB), carpet and padding, gypsum board, and tack strips. Additional materials are described below.

Rimboard – The nominal 1-1/8 in. by 12 in. OSB measured 1-1/8 in. thick by 11-15/16 in. wide and 144 in.

Erection of Test Assembly

Nominal 2 in. by 4 in. structural grade wood bearing plates were placed on top of the steel angles. The wood I joists were placed on the wood bearing plates and spaced 24 in. OC starting at the East-West centerline of the assembly. The joists were fire stopped with 144 in. long pieces of rimboard. At the North and South ends of the assembly, two additional wood I joists, not in the field of the fire for the test, were placed on the North and South edges of the assembly over the vermiculite concrete in order stabilize the wood tongue and groove subfloor. The average bearing at each end of the truss was 2-1/4 in. The trusses were fastened to each bearing plate with two No. 8d coated sinker nails spaced 12 in. OC.

The nominal 8 ft by 4 ft tongue and groove subfloor boards were laid perpendicular to the wood I joists. A 1/4 in. bead of adhesive was placed on the top flange of each wood I joist and a 1/8 in. bead of adhesive was placed on the tip of the tongue and groove connection prior to sliding the subfloor panels together and set in place. The subfloor panels were secured in place with 1-7/8 in. long ringshank underlayment nails spaced 6 in. OC at the edges of the panels and 12 in. OC in the field of each panel.

The pre-nailed tack strips were secured to the subfloor around the perimeter of the assembly approximately 2 in. from the inside edge of the test frame.

The 6 ft wide carpet padding had joints spaced 6 ft, 12 ft and 17 ft 6 in. starting at the South edge of the assembly. The carpet padding was secured to the subfloor with 1/4 in. long staples spaced 18 in. OC around the perimeter of each laid piece of padding.

The 14 ft 3 in wide by 18 ft long roll of carpet was laid on top of the carpet padding. The carpet was stretched tight and secured to the carpet gripper nailing strips located at the perimeter of the entire assembly.

The gypsum board was secured to the exposed side of the assembly with 1-5/8 in. long phosphate coated drywall nails spaced 7 in. OC with nails spaced 1 in from the edge in the field and at the perimeter. The East-West gypsum board joints were staggered 48 in. as to not align any East-West joints. The North-South gypsum board joints were aligned and spaced 48 in. OC. The long edges of the boards were oriented perpendicular to the joists. Two layers of dry mix joint compound was used to cover all gypsum board joints and nails heads.

Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The location of instrumentation within the furnace and on the test sample is shown in Appendix A.

The temperatures of the wood I joists were measured with 20 thermocouples. Thermocouple numbers 31-40 were located on bottom of the I joist and thermocouple numbers 41-50 were located on the side of joist mid depth facing North and were stapled to the trusses.

The temperatures within the interstitial space were measured with 20 thermocouples. Thermocouple numbers 61-70 were located at the center of the interstitial space mid depth and thermocouple numbers 71-80 were located at the center of the interstitial space on the bottom of the subfloor.

The temperatures between the subfloor and carpet padding were measured with 15 thermocouples and numbered 1-15.

The temperatures on top of the carpet padding (between the carpet padding and carpet) were measured with 15 thermocouples and numbered 16-30.

The unexposed temperatures were measured with 13 thermocouples and numbered 81-93. Each of the unexposed surface thermocouples was covered with a 6 by 6 in. dry ceramic fiber pad.

The deflection of the assembly was measured with five electronic transducers.

The temperatures on the unexposed side of the gypsum board (between the gypsum board and the subfloor) were measured with 10 thermocouples and numbered 51-60.

There were a total of eight camera views taken during the fire exposure period. Two cameras were positioned in the interstitial spaced in the cavities under both the kneeling and standing mannequins, both cameras were facing West. One camera was positioned in the furnace recording the exposed surface of the assembly. Four other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Two accelerometers were placed near the East West centerline of the assembly. One was placed on the East West centerline and the other was placed 12 in. North of the East West centerline. They were both located 12 in. off the West edge of the assembly. These were uses to measure the vertical acceleration of the assembly throughout the fire exposure.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 22.

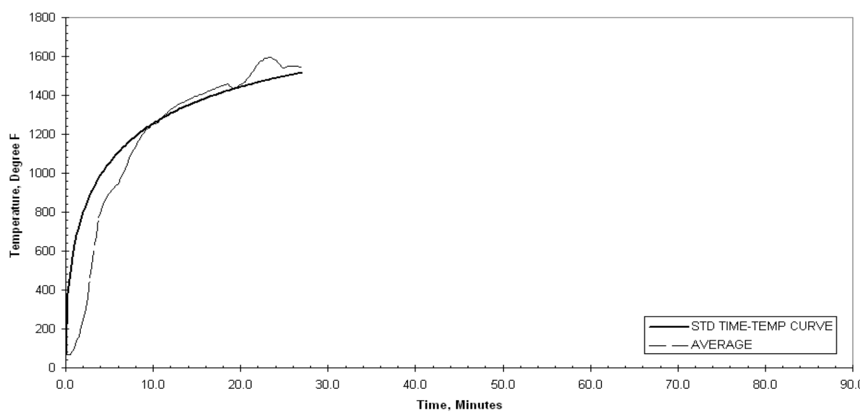


Figure 22 - UL263 Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Assembly No. 4

The furnace pressure and oxygen concentration during the test are shown in Figure 23 and Figure 24.

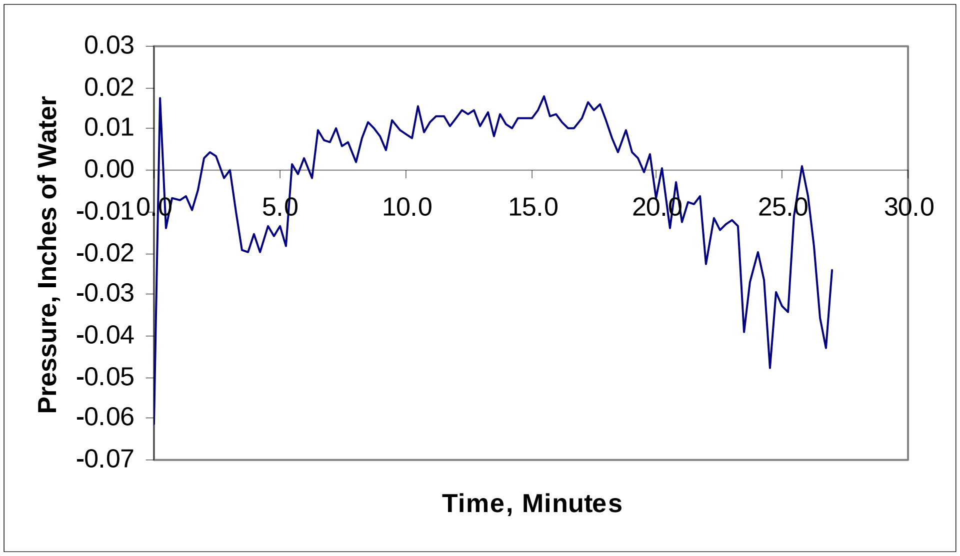


Figure 23 – Furnace Pressure vs. Time for Assembly No. 4

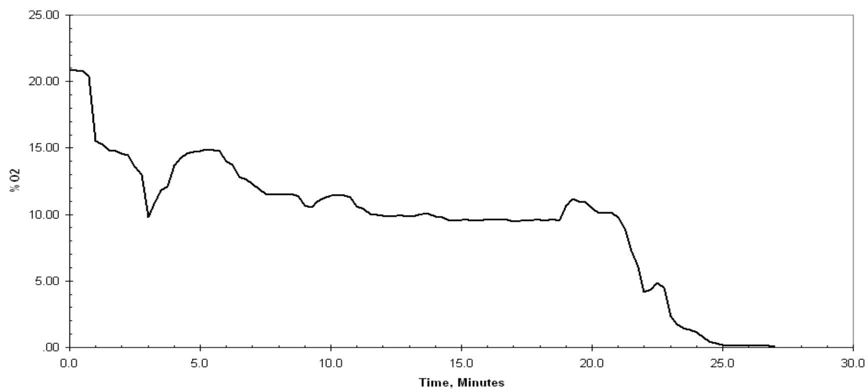


Figure 24 - Oxygen Content vs. Time for Assembly No. 4

Observations of the Exposed and Unexposed Surfaces - The observations were made during the fire test are presented in Table 7. All references to dimensions are approximate.

Table 7 – Observations for Test Assembly No. 4

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
1:15	E	Paper began to char.
2:00	E	Paper ignited.
2:00	U	No Change.
2:30	E	Per plenum camera, smoke was seen in plenum.
4:00	U	No Change.
4:30	E	Joint compound began to crack at butt joints.
5:30	E	Paper flaked off. (TC # 65 Backwards)
6:00	U	No Change.
7:45	E	Joint tape began to peel from board in spots.
8:00	U	No Change.
9:30	E	Board was wavy in appearance from joist to joist.
10:00	E	Joint compound began to fall off.
10:00	U	No Change.
11:00	E	Board turned gray in color
12:00	U	No Change.
12:45	E	50% of joint compound had fallen off.
14:00	U	No Change.
16:00	U	No Change.
16:45	E	85% of joint compound had fallen off.
17:15	E	Gypsum board beginning to fall on North end of assembly.
18:00	E	Gypsum board fell from Center and South ends of the assembly.
18:00	U	No Change.
18:15	U	Smoke began to emit through carpet at East Center subfloor joint.
19:00	U	Smoke at West Center subfloor joint.
19:15	E	40% of board fell off.
20:00	U	Smoke continued at all central joints.
20:40	U	Holes developed through Carpet at West Center subfloor joint at South end of assembly.
20:45	E	Heavy flaming and board continued to fall.
21:15	E	No visual observation could be made due to poor visibility.
22:26	U	Microphone on kneeling mannequin began to vibrate.
23:30	E	Crackling noises could be heard.
23:45	U	Vibrations Continued.
25:00	E	Furnace TC #15 fell.
25:00	U	Vibrations Continued.
26:45	U	Assembly Collapse.
26:45	E	Collapse

Temperatures of the Wood I Joists - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom chords nearest the fire 250°F or the time required to raise the temperature on the bottom chords 325°F at any point. The average temperature measured on the bottom chords of the trusses was 67°F before the test. Therefore, the average limiting temperature was 317°F and the individual limiting temperature was 392°F.

The maximum individual limiting temperature for the finish rating was reach at 7 minutes and 45 seconds as recorded by thermocouple number 31.

Temperatures of the Side of Mid Depth of Wood Joists – The average and maximum temperatures of the sides of the wood joists just before the moment of collapse (26 min 45 sec) were 1467°F and 1597°F respectively. The individual temperature was recorded by thermocouple number 48. A plot of these temperatures can be seen on Figure 25.

Temperatures of the Mid Depth Between Wood Joists – The average and maximum temperatures of the mid depth between the wood joists just before the moment of collapse (26 min 45 sec) were 1475°F and 1547°F respectively. The individual temperature was recorded by thermocouple number 70. A plot of these temperatures can be seen on Figure 25.

Temperatures of the Bottom of the Sub Floor Between Wood Joists – The average and maximum temperatures of the sub floor between the wood joists just before the moment of collapse (26 min 45 sec) were 1467°F and 1549°F respectively. The individual temperature was recorded by thermocouple number 80. A plot of these temperatures can be seen on Figure 25.

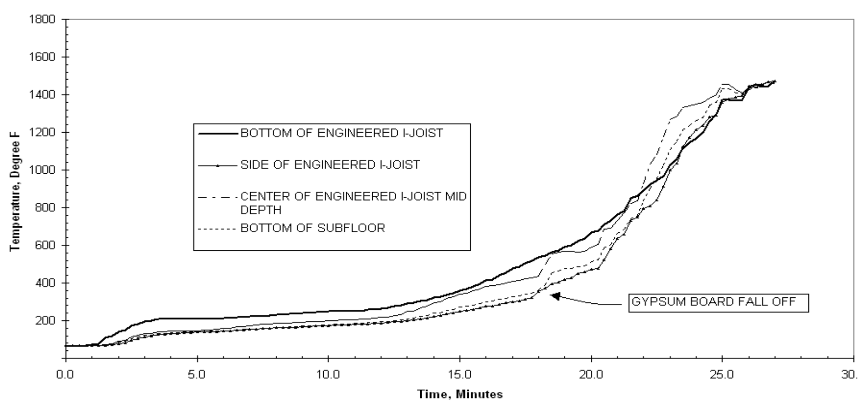


Figure 25 - Plot of Temperatures Below Subfloor vs. Time for Assembly No. 4

Temperatures of the Unexposed Side of Gypsum Board – The average and maximum temperatures of the unexposed surface just before the gypsum board fall off (17 min 15 sec) were 531°F and 634°F respectively. The individual temperature was recorded by thermocouple number 57. A plot of these temperatures can be seen on Figure 26.

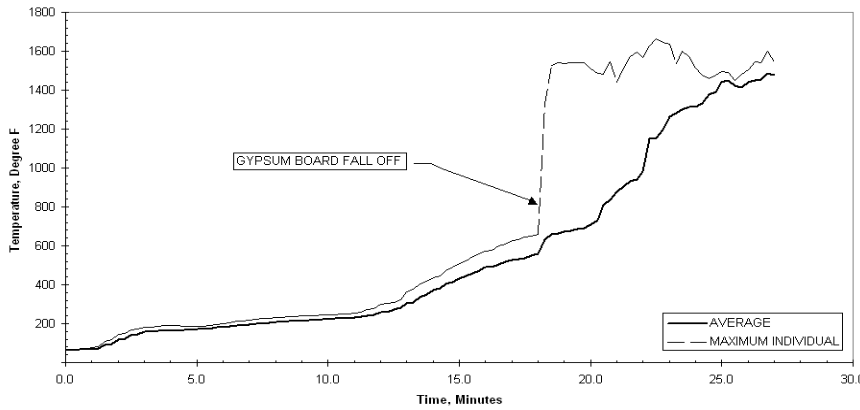


Figure 26 - Plot of Temperature of the Unexposed Surface of Gypsum Board vs. Time for Assembly No. 4

Temperatures Between the Sub Floor and Carpet Padding – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (26 min 45 sec) were 191°F and 361°F respectively. The individual temperature was recorded by thermocouple number 7. A plot of these temperatures can be seen on Figure 27.

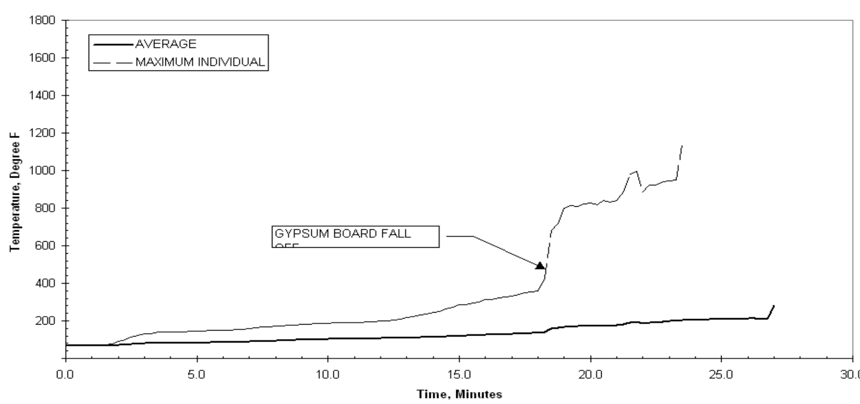


Figure 27 - Plot of Temperature of the Subfloor Temperatures vs. Time

Temperatures Between the Carpet Padding and Carpet – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (26 min 45 sec) were 135°F and 188°F respectively. The individual temperature was recorded by thermocouple number 29. A plot of these temperatures can be seen on Figure 28.

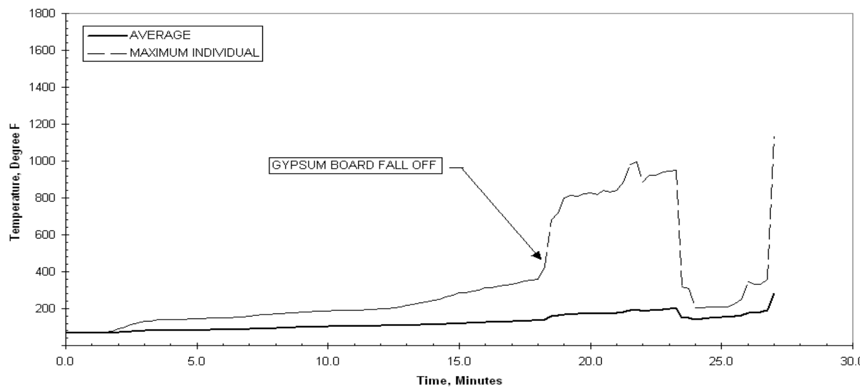


Figure 28 - Plot of Temperature of the Carpet Padding vs. Time for Assembly No. 4

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (26 min 45 sec) were 144°F and 355°F respectively. The individual temperature was recorded by thermocouple number 87. A plot of these temperatures can be seen on Figure 29.

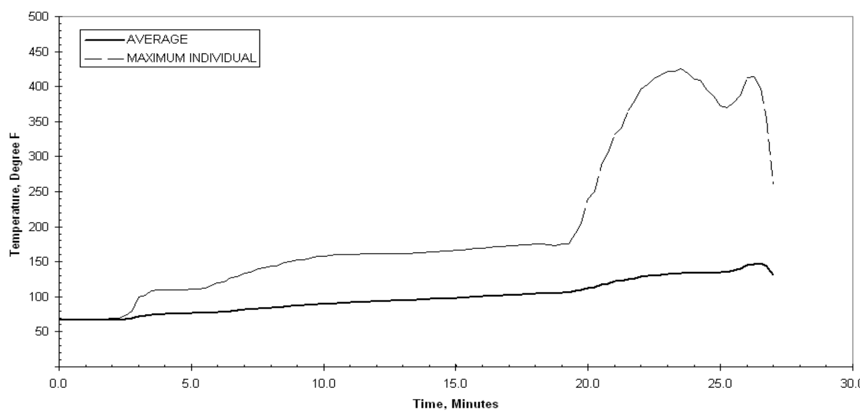


Figure 29 - Plot of Temperature of the Unexposed Surface vs. Time for Assembly No. 4

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 30. The location of each deflection transducer can be seen in Appendix A under Test Assembly 4.

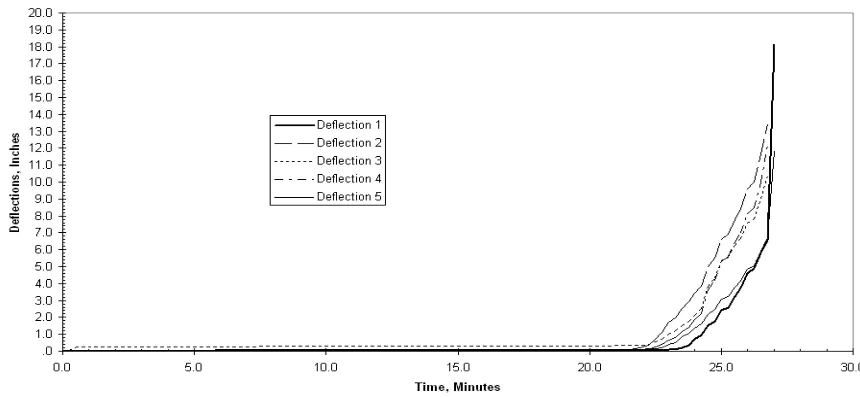


Figure 30 - Plot of Deflections vs. Time for Assembly No. 4

Test Record No. 5

Materials

Materials described in section General and used in Assembly No. 5 include engineered 2 by 6 bearing plate, subfloor (OSB), carpet and padding, tack strips, and gypsum board. Additional materials are described below.

Trusses - The parallel chord trusses were 14 in. deep, 13 ft 10 in. long fabricated from nominal 2 in. by 4 in. wood members and had an average weight of 54.08 lb. The nominal 4 in. side of the truss members was oriented in the horizontal direction. The truss members were secured together with galvanized steel plates measuring 0.036 in. thick for 1.5 in. by 4 in., 3 in. by 4 in., 3 in. by 7in., 3.5 in. by 8 in. and 3 in. by 10 in. sizes. The plates contained 5/16 in. long teeth projecting perpendicular to the plane of the plate. The moisture content of the truss members ranged from 3.4 to 12.1 percent and averaged 9.2 percent.

End Closure – The nominal 2 in. by 4 in. dimensional lumber measured 1-1/2 in. by 3-1/2 in. and cut to lengths of 8 ft 8-5/8 in. long.

Strongback – The nominal 2 in. by 6 in. dimensional lumber measured 1-1/2 in. by 5-1/2 in. and cut to lengths of 5 ft 7-3/4 in. and 12 ft 3/8 in. long.

Erection of Test Assembly

Nominal 2 in. by 6 in. structural grade wood bearing plates were placed on top of the steel angles. The trusses were placed on the wood bearing plates and spaced 24 in. OC starting at the East West centerline of the assembly. At the North and South ends of the assembly, additional trusses, not in the field of the fire test, were placed over the vermiculite concrete in order stabilize the plywood subfloor. The average bearing at each end of the truss was 4-7/8 in. The trusses were fastened to each bearing plate with two No. 16d nails.

Nominal 2 in. by 6 in. structural grade strongback was run perpendicular to the vertical member of the trusses located 5 ft 7-1/2 in. from the West side of the assembly. The strongback was secured to the vertical wood members of the trusses with two No. 16d nails at each strongback / truss interface.

Along the east and west edges of the test assembly, nominal 2 in. by 4 in. wood headers (rim band) were spaced perpendicular to the trusses and fastened to the top chord of each truss with two No. 16d nails.

A 1/4 in. wide bead of adhesive was placed on the top chord of the trusses and into the grooved edge of the plywood. The plywood sub-floor was placed on the trusses with the 8 ft long edges positioned perpendicular to the trusses and the ends butted and centered over trusses, with adjacent end joints staggered 4 ft. A 1/8 in. wide bead of adhesive was placed on the tip of the tongue and groove ends of the subfloor before sliding the panels together. The plywood was secured to the trusses with 1-7/8 in. ringshank underlayment nails spaced 6 in. OC at the perimeter and 12 in. OC in the field with nails 1 in. from the edge of each panel.

The pre-nailed tack strips were secured to the subfloor around the perimeter of the assembly approximately 2 in. from the inside edge of the test frame.

The 6 ft wide carpet padding had joints spaced 6 ft,12 ft and 17 ft 6 in. starting at the West edge of the assembly. The carpet padding was secured to the subfloor with 1/4 in. long staples spaced 18 in. OC around the perimeter of each laid piece of padding.

The 14 ft 3 in. wide by 18 ft long roll of carpet was laid on top of the carpet padding. The carpet was stretched tight and secured to the carpet gripper nailing strips located at the perimeter of the entire assembly.

The gypsum board was secured to the exposed side of the assembly with 1-5/8 in. long phosphate coated drywall nails spaced 7 in. OC with nails spaced 1 in from the edge in the field and at the perimeter. The East-West gypsum board joints were staggered 48 in. as to not align any East-West joints. The North-South gypsum board joints were aligned and spaced 48 in. OC. The long edges of the boards were oriented perpendicular to the joists. Two layers of dry mix joint compound was used to cover all gypsum board joints and nails heads.

Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The location of instrumentation within the furnace and on the test sample are shown in Appendix A.

The temperatures of the wood trusses were measured with 20 thermocouples numbered 31-40 were located on the bottom of the trusses and thermocouple numbers 41-50 were located on the side of trusses mid depth facing North and stapled to the trusses.

The temperatures within the interstitial space were measured with 26 thermocouples. These thermocouples were numbered 61-70 and located at the center of the interstitial space mid depth. Thermocouple numbers 71-80 were located at the center of the interstitial space on the bottom of the subfloor. Thermocouples numbered 81-83 were located on the bottom metal gusset plates nearest center of assembly facing North. Thermocouples numbered 84-86 were located on the top metal gusset plates nearest center of assembly facing North.

The temperatures between the subfloor and carpet padding were measured with 15 thermocouples and numbered 1-15.

The temperatures on top of the carpet padding (between the carpet padding and carpet) were measured with 15 thermocouples and numbered 16-30.

The unexposed surface temperatures were measured with 13 thermocouples and numbered 87-99. Each thermocouple was covered with a 6 by 6 in. dry ceramic fiber pad.

The temperatures on the unexposed side of the gypsum board (between the gypsum board and the subfloor) were measured with 10 thermocouples and numbered 51-60.

The deflection of the assembly was measured with five electronic transducers.

There were a total of eight camera views taken during the fire exposure period. One camera was positioned in the furnace recording the exposed surface of the assembly, two cameras positioned in the interstitial space between the gypsum board and sub floor. Four other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 31.

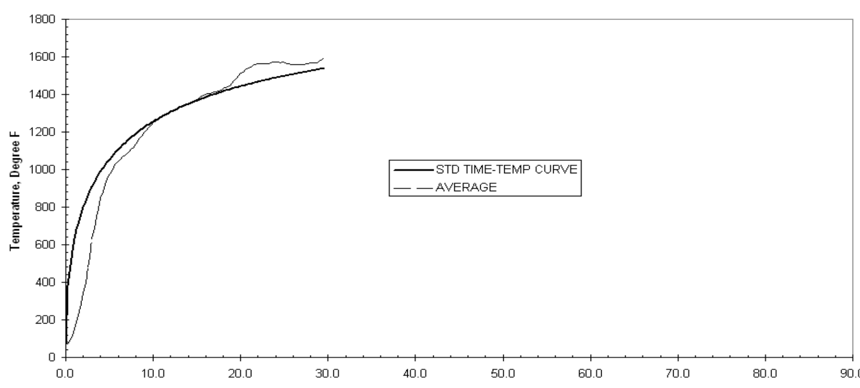


Figure 31 - UL263 Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Assembly No. 5

The furnace pressure and oxygen concentration during the test are presented in Figure 32 and Figure 33.

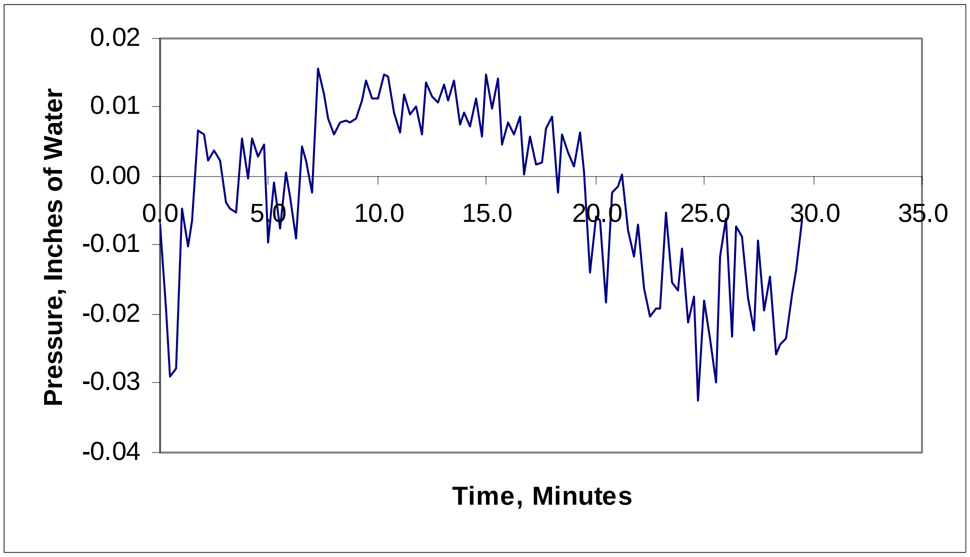


Figure 32 - Furnace Pressure vs. Time for Assembly No. 5

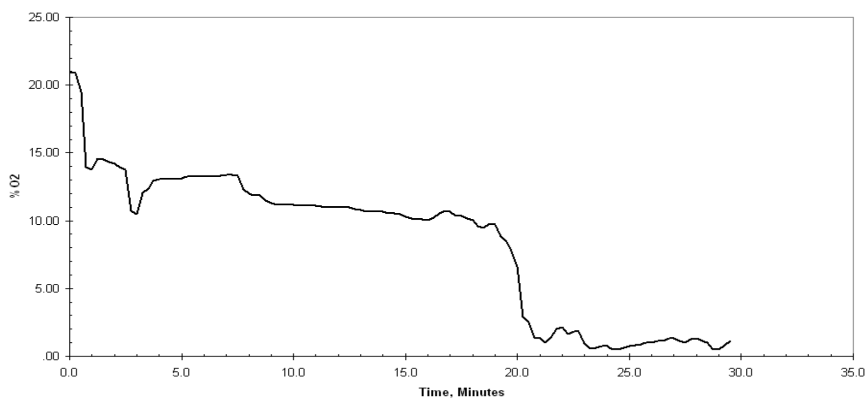


Figure 33 - Oxygen Content vs. Time for Assembly No. 5

Observations of the Exposed and Unexposed Surfaces - The observations made during the fire test are presented in Table 8. All references to dimensions are approximate.

Table 8 – Observations for Assembly No. 5

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
1:30	E	Paper surface ignited.
2:00	U	No change.
2:30	E	Paper charred and black in color.
4:00	U	No change.
6:00	U	No change.
6:15	E	Joint compound buckled and surface turned gray in color.
8:00	U	No change.
8:30	E	Joint compound fell from joints.
10:00	U	Smoke emitted fro perimeter of assembly at saddles and penetrations.
10:30	E	20% of joint compound had fallen off.
12:00	U	Smoke at perimeter continued. Slightly intensified.
12:30	E	Joint compound continued to fall off. 75% had fallen off.
14:00	U	No change.
16:00	U	No change.
16:30	E	2 ft by 4 ft piece of gypsum had fell off. The West adjacent had large cracks.
17:45	E	Board continued to fall off.
18:00	U	No change at perimeter. Smoke began to emit from assembly at subfloor joints.
18:15	E	Large pieces of gypsum board continued to fall. About 50%-60% gone.
18:45	E	70%-75% of the gypsum board had fallen off.
19:00	E	Crackling sounds from the trusses could be heard.
19:50	U	Crackling form assembly could be heard.
20:00	E	Could not see in furnace through windows of camera.
21:15	U	Intense smoke over entire surface. Holes could be seen through carpet at subfloor joints.
21:45	E	Crackling noises continued.
24:30	U	Flame through at TC hole.
25:30	E	Still no visual observations could be made.
25:30	U	Smoke was puffing at east side of assembly.
26:20	U	Carpet buckled at subfloor joints.
27:45	U	Flame through at west edge perimeter
28:00	E	Mannequin dropped a few inches.
28:40	U	Flame through along center truss.
28:49	E	Mannequin dropped a few inches.
29:15	E	Mannequin fell through. Gas off.
29:15	U	Mannequin fell through. Gas off.

Temperatures of the Trusses - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom chords nearest the fire 250°F or the time required to raise the temperature on the bottom chords 325°F at any point. The average temperature measured on the bottom chords of the trusses was 71°F before the test. Therefore, the average limiting temperature was 321°F and the individual limiting temperature was 396°F.

The maximum individual limiting temperature for the finish rating was reach at 10 minutes and 45 seconds as recorded by thermocouple number 36. A plot of the finish rating temperatures can be seen on Figure 5.4.

Temperatures at Mid Depth on the Side the Wood Trusses – The average and maximum temperatures of the sides of the wood trusses just before the moment of collapse (29 min 15 sec) were 1488°F and 1561°F respectively. The individual temperature was recorded by thermocouple number 41. A plot of these temperatures can be seen Figure 34.

Temperatures of the Mid Depth Between Wood Trusses – The average and maximum temperatures of the mid depth between the wood trusses just before the moment of collapse (29 min 15 sec) were 1464°F and 1534°F respectively. The individual temperature was recorded by thermocouple number 63. A plot of these temperatures can be seen on Figure 34.

Temperatures of the Sub Floor Between Wood Trusses – The average and maximum temperatures of the sub floor between the wood trusses just before the moment of collapse (29 min 15 sec) were 1464°F and 1538°F respectively. The individual temperature was recorded by thermocouple number 71. A plot of these temperatures can be seen on Figure 34.

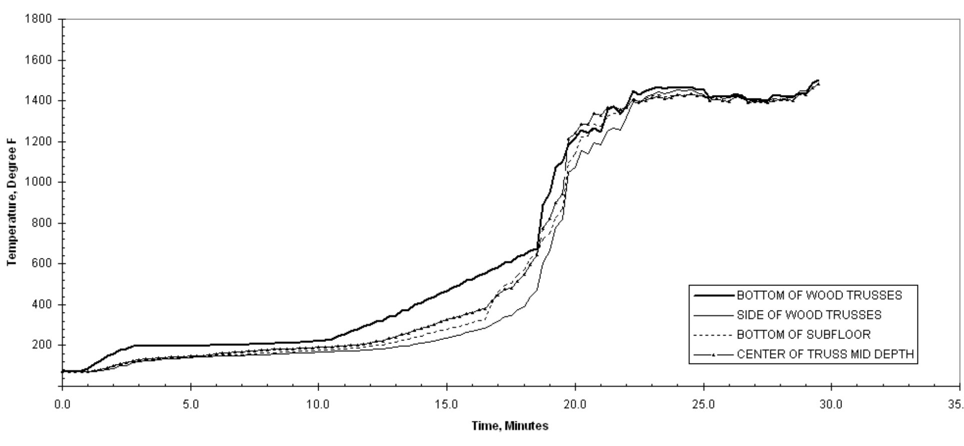


Figure 34 - Plot of Temperature of the Average Interstitial Space vs. Time for Assembly No. 5

Temperatures of the Metal Gusset Plates – The average and maximum temperatures of the top metal gusset plates just before the moment of collapse (29 min 15 sec) were 1487°F and 1537°F respectively. The individual temperature was recorded by thermocouple number 81. The average and maximum temperatures of the bottom metal gusset plate just before the moment of collapse (29 min 15 sec) were 1502°F and 1581°F respectively. The individual temperature was recorded by thermocouple number 86. A plot of the metal gusset temperatures can be seen on Figure 5.5.

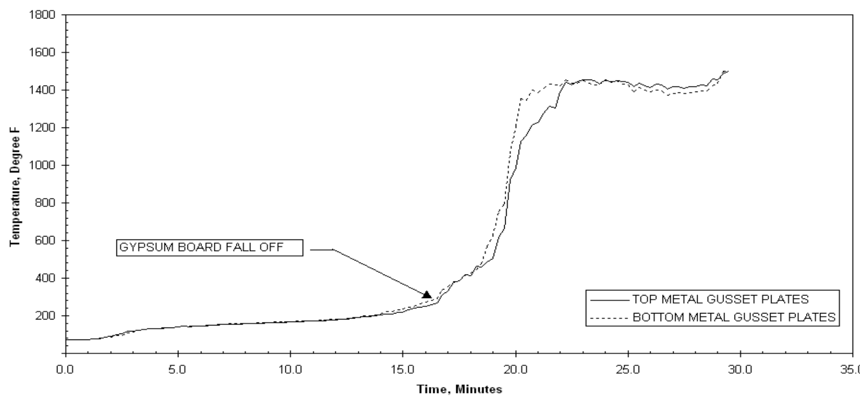


Figure 35 - Plot of Temperature of the Top and Bottom Metal Gusset Plates vs. Time for Assembly No. 5

Temperatures of the Unexposed Side of Gypsum Board – The average and maximum temperatures of the unexposed surface just before the gypsum board fall off (16 min 30 sec) were 519°F and 606°F respectively. The individual temperature was recorded by thermocouple number 54. A plot of these temperatures can be seen on Figure 36.

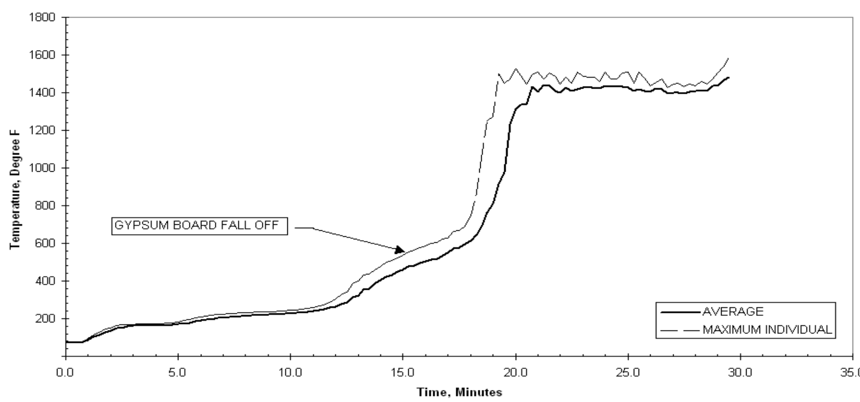


Figure 36 - Plot of Temperature of the Unexposed Surface of Gypsum Board vs. Time for Assembly No. 5

Temperatures Between the Sub Floor and Carpet Padding – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (29 min 15 sec) were 459°F and 1416°F respectively. The individual temperature was recorded by thermocouple number 9. A plot of these temperatures can be seen on Figure 37.

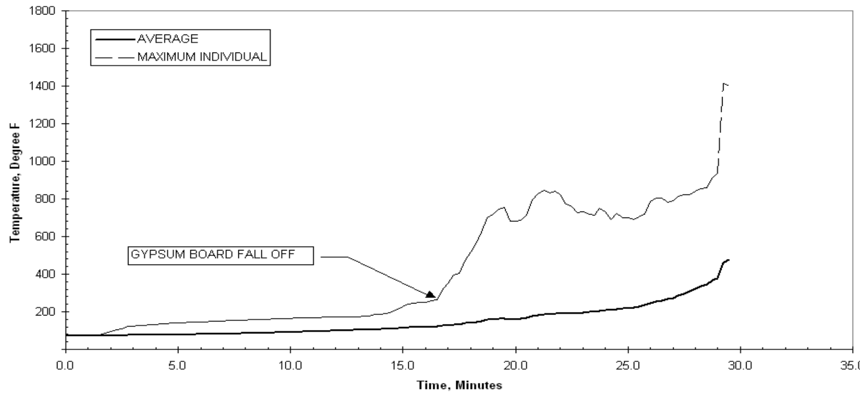


Figure 37 - Plot of Temperature of the Subfloor Temperatures vs. Time for Assembly No. 5

Temperatures Between the Carpet Padding and Carpet – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (29 min 15 sec) were 256°F and 636°F respectively. The individual temperature was recorded by thermocouple number 24. A plot of these temperatures can be seen on Figure 38.

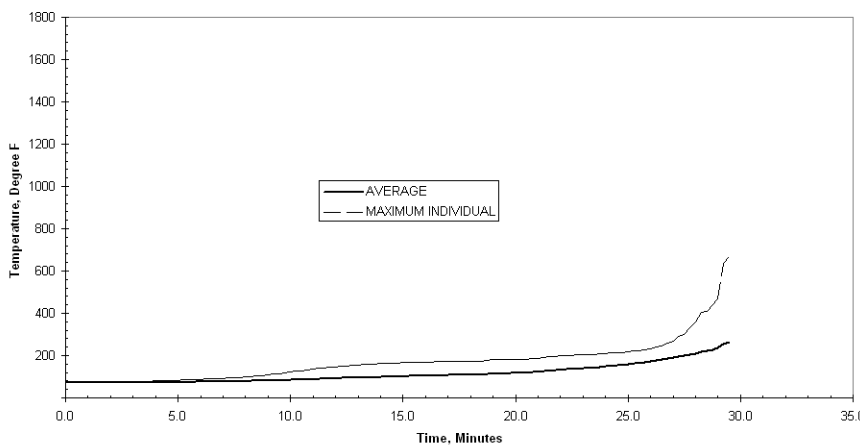


Figure 38 - Plot of Temperature of the Carpet Padding vs. Time for Assembly No. 5

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (29 min 15 sec) were 194°F and 474°F respectively. The individual temperature was recorded by thermocouple number 96. A plot of these temperatures can be seen on Figure 5.9.

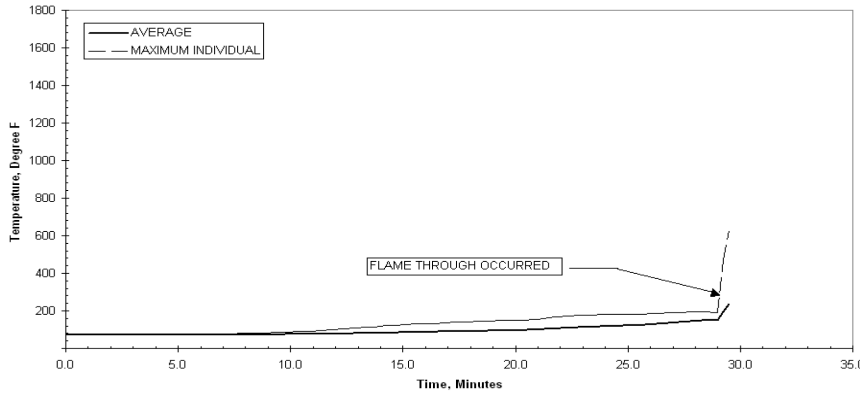


Figure 39 - Plot of Temperatures of the Unexposed Surface vs. Time for Assembly No. 5

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 40. The location of each deflection transducer can be seen in Appendix A under Test Assembly 5.

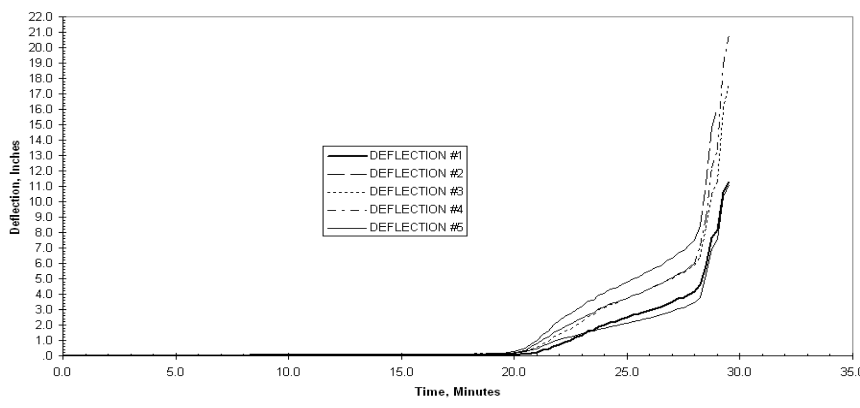


Figure 40 - Plot of Deflections vs. Time for Assembly No. 5

Test Record No. 6

Materials

Materials described in section General and used in Assembly No. 6 include engineered 2 by 6 bearing plate, subfloor (OSB), carpet and padding, tack strips, and gypsum board. Additional materials are described below.

Trusses - The glued finger jointed trusses were nominally 14 in. deep, 14 ft long fabricated from nominal 2 in. by 2 in. wood members with nominal 2 in. 3 in. wide top and bottom chords and had an average weight of 34.36 lb. The top and bottom chords measured 2-1/2 in. wide by 1-1/2 in. high. The web members measured 1-1/2 in. wide by 1-1/2 in. high and the finger penetrated 3/4 in. into the top and bottom chords. Nominal 2 in. by 6 in. and 2 in. by 8 in. wood members were used as vertical and diagonal members inside each truss. The moisture content of the truss members ranged from 4.9 to 8.4 percent and averaged 7.55 percent.

End Closure (Wood Headers) **–** The nominal 2 in. by 4 in. dimensional lumber measured 1-1/2 in. by 3-1/2 in. and cut to lengths of 104-5/8 in. long.

Erection of Test Assembly

Nominal 2 in. by 6 in. structural grade wood bearing plates were placed on top of the steel angles. The trusses were placed on the wood bearing plates and spaced 24 in. OC starting at the East West centerline of the assembly. At the North and South ends of the assembly, additional trusses, not in the field of the fire test, were placed over the vermiculite concrete in order stabilize the plywood subfloor. The average bearing at each end of the truss was 4-7/8 in. The trusses were fastened to each bearing plate with two No. 16d nails.

Along the east and west edges of the test assembly, nominal 2 in. by 4 in. wood headers (rim band) were placed perpendicular to the trusses and fastened to the top chord of each truss with two No. 16d nails.

A 1/4 in. wide bead of adhesive was placed on the top chord of the trusses and into the grooved edge of the plywood. The plywood sub-floor was placed on the trusses with the 8 ft long edges positioned perpendicular to the trusses and the ends butted and centered over trusses, with adjacent end joints staggered 4 ft. A 1/8 in. wide bead of adhesive was placed on the tip of the tongue and groove ends of the subfloor before sliding the panels together. The plywood was secured to the trusses with 6d ringshank underlayment nails spaced 6 in. OC at the perimeter and 12 in. OC in the field with nails 1 in. from the edge of each panel.

The pre-nailed tack strips were secured to the subfloor around the perimeter of the assembly approximately 2 in. from the inside edge of the test frame.

The 6 ft wide carpet padding had joints spaced 6 ft 12 ft and 17-1/2 ft starting at the South edge of the assembly. The carpet padding was secured to the subfloor with 1/4 in. long staples spaced 18 in. OC around the perimeter of each laid piece of padding.

The 14-1/4 ft wide by 18 ft long roll of carpet was laid on top of the carpet padding. The carpet was stretched tight and secured to the carpet gripper nailing strips located at the perimeter of the entire assembly.

The gypsum board was secured to the exposed side of the assembly with 1-5/8 in. long phosphate coated drywall nails spaced 7 in. OC with nails spaced 1 in from the edge in the field and at the perimeter. The East-West gypsum board joints were staggered 48 in. as to not align any East-West joints. The North-South gypsum board joints were aligned and spaced 48 in. OC. The long edges of the boards were oriented perpendicular to the joists. Two layers of dry mix joint compound was used to cover all gypsum board joints and nails heads.

Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The location of instrumentation within the furnace and on the test sample are shown in Appendix A.

The temperatures of the wood trusses were measured with 20 thermocouples. Thermocouple numbers 31-40 were located on the bottom of the trusses and thermocouple numbers 41-50 were located on the side of trusses mid depth facing North and stapled to the trusses.

The temperatures within the interstitial space were measured with 26 thermocouples. Thermocouple numbers 61-70 were located at the center of the interstitial space mid depth. Thermocouple numbers 71-80 were located at the center of the interstitial space on the bottom of the subfloor. Thermocouple numbers 81-83 were located on the bottom glued finger joints nearest center of assembly facing North and thermocouple numbers 84-86 were located on the top glued finger joints nearest center of assembly facing North.

The temperatures between the subfloor and carpet padding were measured with 15 thermocouples and numbered 1-15.

The temperatures on top of the carpet padding (between the carpet padding and carpet) were measured with 15 thermocouples and numbered 16-30.

The unexposed temperatures were measured with 13 thermocouples and numbered 87-99. Each of the unexposed surface thermocouples was covered with a 6 by 6 in. dry ceramic fiber pad.

The temperatures on the unexposed side of the gypsum board (between the gypsum board and the subfloor) were measured with 10 thermocouples and numbered 51-60.

The deflection of the assembly was measured with five electronic transducers.

There were a total of eight camera views taken during the fire exposure period. One camera was positioned in the furnace recording the exposed surface of the assembly, two cameras positioned in the interstitial space between the gypsum board and sub floor. Four other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 41.

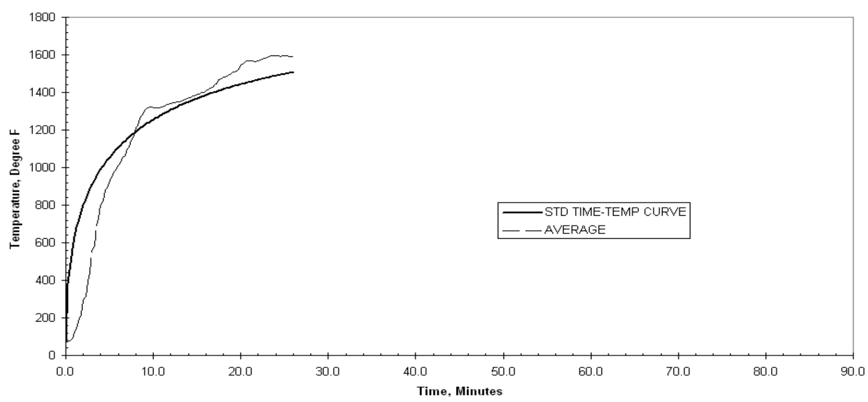


Figure 41 - UL263 Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Assembly No. 6

The furnace pressure and oxygen concentration are presented in Figure 42 and Figure 43.

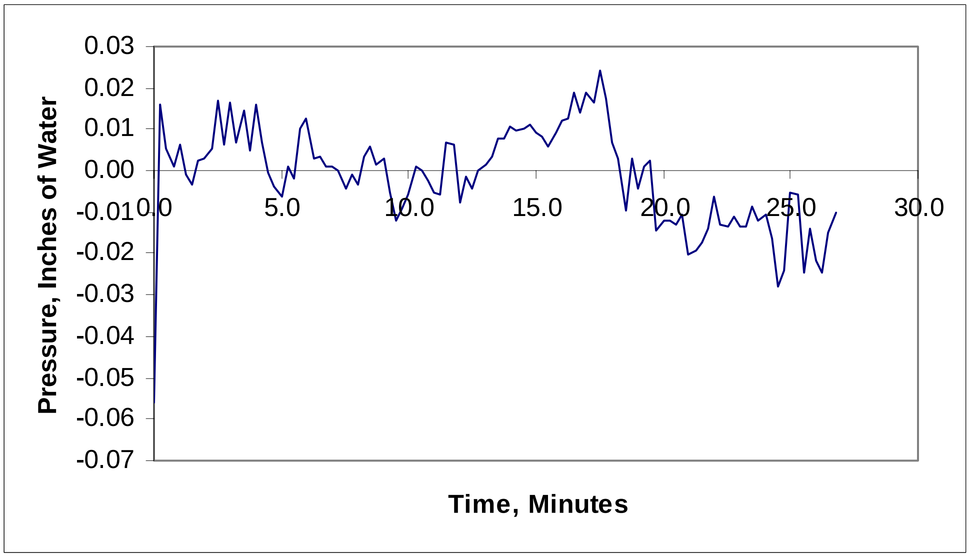


Figure 42 - Furnace Pressure vs. Time for Assembly No. 6

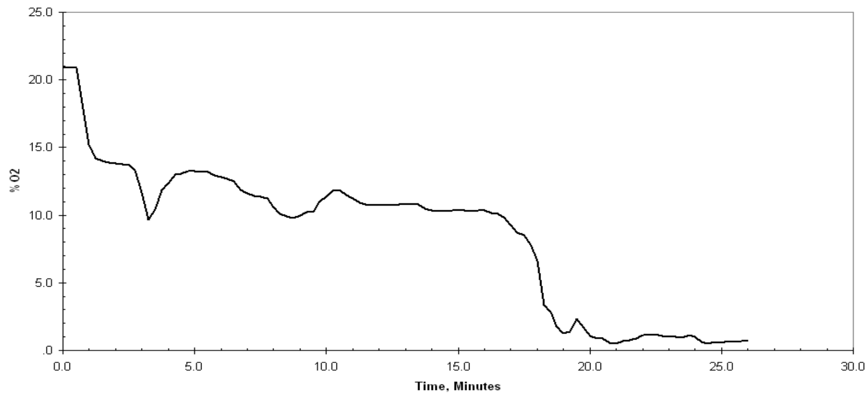


Figure 43 - Oxygen Content vs. Time for Assembly No. 6

Observations of the Exposed and Unexposed Surfaces - The observations made during the fire test are shown in Table 9. All references to dimensions are approximate.

Table 9 – Observations for Assembly No. 6

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
2:00	E	Paper surface ignited.
2:00	U	No change.
4:00	U	No change.
4:30	E	Surface charred and began to flake.
6:00	U	Smoke emitting from perimeter at saddles.
7:00	E	Joint compound began to crack along joints and started to peal away.
7:30	E	Surface gray in color.
8:00	U	No change.
10:00	U	No change.
10:30	E	Joint compound began to fall off.
12:00	U	Smoke increased at saddles.
13:30	E	80% of joint compound had fallen off.
14:00	U	No change.
15:30	E	North Center gypsum board joint opened to about 1/4 in. to 3/8 in.
16:00	E	2 ft by 3 ft piece of gypsum board fell off.
16:00	U	No change.
16:20	U	Smoke came from subfloor joints.
16:45	E	Gypsum board fall off continued.
17:00	E	Gypsum board fall off continued.
17:30	E	Gypsum board fall off continued.
17:30	U	Smoke increased.
18:10	U	Holes were present through carpet at East subfloor joint. Crackling could be heard.
18:45	E	No visual observations could be made.
19:20	U	Smoke continued to increase.
23:00	U	Smoke stabilized and crackling continued. Very little deflection had occurred.
23:15	U	Standing mannequin vibrated.
23:40	U	Buckling of subfloor was present near kneeling mannequin.
23:51	U	Both mannequins vibrated.
24:00	U	Sudden drops in surface as truss joints popped.
24:23	U	Both mannequins vibrated.
25:54	U	Large amount of deflection was visible.
26:00	U	Flame through at West edge. East and Center occurred shortly after.
26:45	U/E	Mannequin fell through. Gas off.

Temperatures of the Trusses - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom chords nearest the fire 250°F or the time required to raise the temperature on the bottom chords 325°F at any point. The average temperature measured on the bottom chords of the trusses was 70°F before the test. Therefore, the average limiting temperature was 320°F and the individual limiting temperature was 395°F.

The maximum individual limiting temperature for the finish rating was reach at 12 minutes and 15 seconds as recorded by thermocouple number 39. A plot of the finish rating temperatures can be seen on Figure 6.4.

Temperatures at Mid Depth on the Side the Wood Trusses – The average and maximum temperatures of the sides of the wood trusses just before the moment of collapse (26 min 45 sec) were 1422°F and 1487°F respectively. The individual temperature was recorded by thermocouple number 45. A plot of these temperatures can be seen on Figure 6.4.

Temperatures of the Mid Depth Between Wood Trusses – The average and maximum temperatures of the mid depth between the wood trusses just before the moment of collapse (29 min 45 sec) were 1403°F and 1474°F respectively. The individual temperature was recorded by thermocouple number 66. A plot of these temperatures can be seen on Figure 6.4.

Temperatures of the Sub Floor Between Wood Trusses – The average and maximum temperatures of the sub floor between the wood joists just before the moment of collapse (29 min 45 sec) were 1411°F and 1476°F respectively. The individual temperature was recorded by thermocouple number 75. A plot of these temperatures can be seen on Figure 6.4.

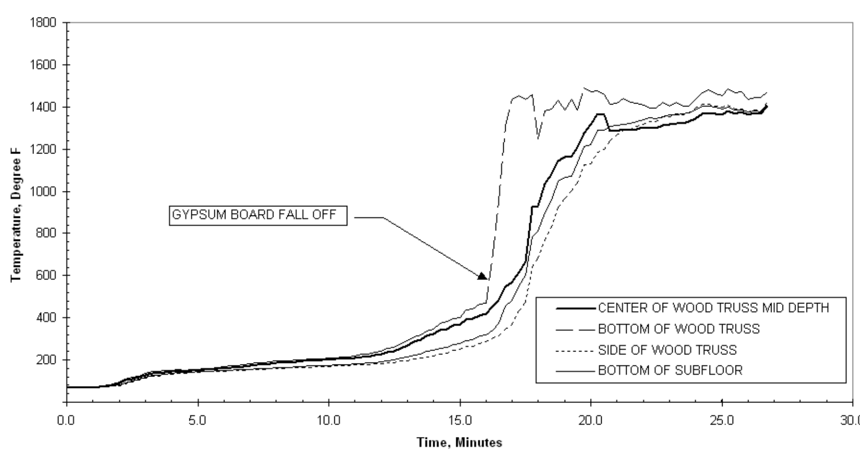


Figure 44 - Plot of Temperatures of Below Subfloor vs. Time

Temperatures of the Glued Finger Joints – The average and maximum temperatures of the top glued finger joints just before the moment of collapse (29 min 45 sec) were 1435°F and 1477°F respectively. The individual temperature was recorded by thermocouple number 84. The average and maximum temperatures of the bottom glued finger joints just before the moment of collapse (29 min 45 sec) were 1434°F and 1474°F respectively. The individual temperature was recorded by thermocouple number 81. A plot of the glued finger joint temperatures can be seen on Figure 6.5.

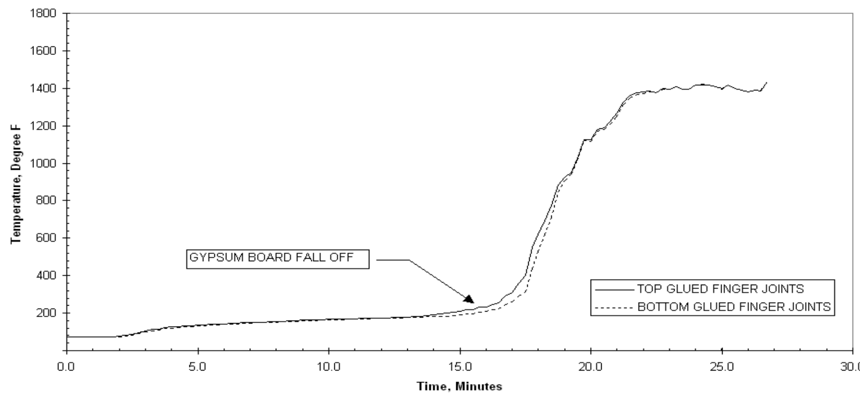


Figure 45 - Plot of Temperature of the Top and Bottom Glued Finger Joints vs. Time for Assembly No. 6

Temperatures of the Unexposed Side of Gypsum Board – The average and maximum temperatures of the unexposed surface just before the gypsum board fall off (16 min) were 559°F and 650°F respectively. The individual temperature was recorded by thermocouple number 52. A plot of these temperatures can be seen on Figure 46.

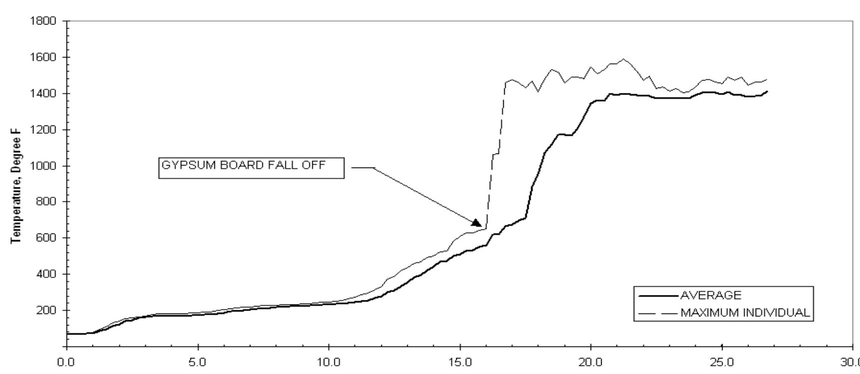


Figure 46 - Plot of Temperature of the Unexposed Surface of Gypsum Board vs. Time for Test Assembly No. 6

Temperatures Between the Sub Floor and Carpet Padding – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (29 min 45 sec) were 424°F and 1240°F respectively. The individual temperature was recorded by thermocouple number 9. A plot of these temperatures can be seen on Figure 47.

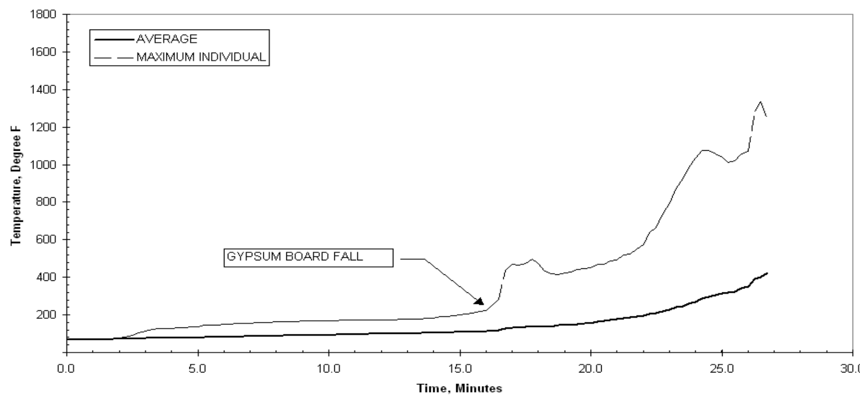


Figure 47 - Plot of Temperature of the Subfloor Temperatures vs. Time for Test Assembly No. 6

Temperatures Between the Carpet Padding and Carpet – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (29 min 45 sec) were 241°F and 843°F respectively. The individual temperature was recorded by thermocouple number 24. A plot of these temperatures can be seen on Figure 48.

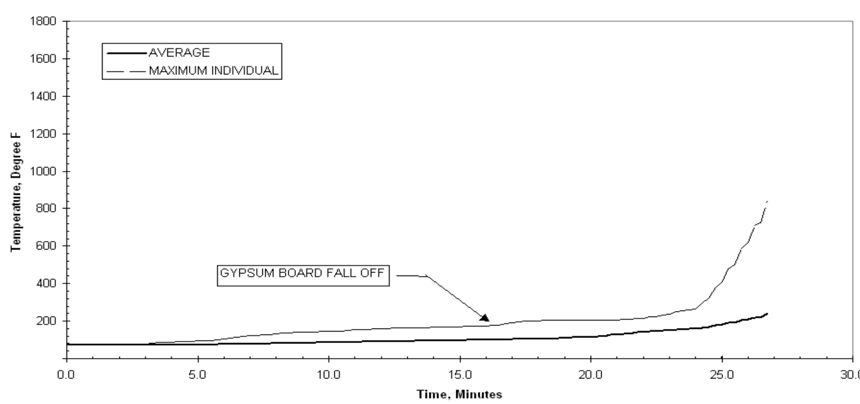


Figure 48 - Plot of Temperature of the Carpet Padding vs. Time for Test Assembly No. 6

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (29 min 45 sec) were 182°F and 646°F respectively. The individual temperature was recorded by thermocouple number 92. A plot of these temperatures can be seen on Figure 49.

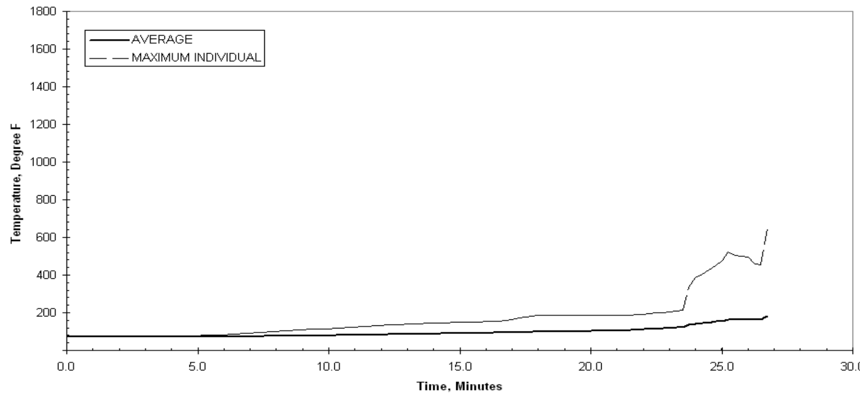


Figure 49 - Plot of Temperatures of the Unexposed Surface vs. Time for Test Assembly No. 6

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 50. The location of each deflection transducer can be seen in Appendix A under Test Assembly 6.

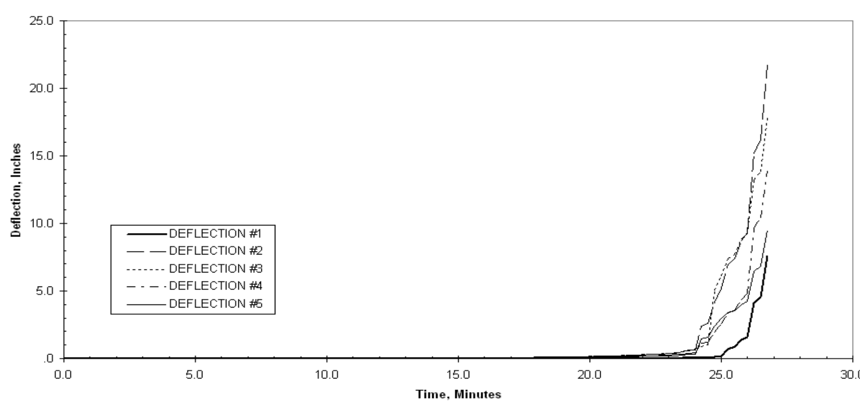


Figure 50 - Plot of Deflections vs. Time for Test Assembly No. 6

Test Record No. 7

Materials

Materials described in section General and used in Assembly No. 7 include engineered 2 by 4 bearing plate, No. 30 asphalt felt, faced batt insulation, gypsum board, and Class A asphalt shingles. Additional materials are described below.

Joist – The nominal 2 in. by 6 in. dimensional lumber measured 1-1/2 in. by 5-1/2 in. and cut to a length of 14 ft 1/12 in. long.

Blocking – The nominal 2 in. by 6 in dimensional lumber was cut to fit the area at the end of each joist. The installed pieces measured 1-1/2 in. by 4-7/8 in. and the top was cut to an angle of approximately 9.5°.

Rafters - The nominal 2 in. by 6 in. dimensional lumber measured 1-1/2 in. by 5-1/2 in. and cut to a length of 6 ft 11-7/8 in. long.

Ridge Beam – The nominal 2 in. by 8 in. dimensional lumber measured 1-1/2 in. by 7-1/2 in. and cut to a length of 13 ft 12-1/4 in. long.

Roof Deck – The nominal 1 in. by 6 in. lumber measured 3/4 in. by 5-1/2 in. by 8 ft 1/4 in. long.

Mushroom Vent – The mushroom shaped attic exhaust measure 15-3/8 in. by 17-5/16 in. at the base and 11 in. by 11-3/8 in. at the cap. The base contained four holes, one at each corner, for attachment. The aluminum thickness of the vent measured on average 0.0205 in. thick. The vents weight an average of 0.975 lbs.

Erection of Test Assembly

Nominal 2 in. by 4 in. structural grade wood bearing plates were placed on top of the steel angles. The 2 in. by 6 in. wood joists were placed on the wood bearing plates and spaced 16 in. OC starting 8 in from each side of the East West centerline of the assembly. At the North and South ends of the assembly, additional joists, not in the field of the fire test, were placed over the vermiculite concrete in order stabilize the roof assembly. The average bearing at each end of the joists were 3-1/4 in. The joists were fastened to each bearing plate with two No. 8d nails. The joists were fire-stopped with nominal 2 in. by 6 in. lumber.

Nominal 2 in. by 6 in. rafters were set to a 2/12 roof system angle and positioned parallel to the horizontal joist members. The rafters were secured to the horizontal joists with four No. 16d nails at each rafter / joist interface.

The ridge beam ran perpendicular to the joists down the North South centerline and was secured to the top of each rafter with two 16d nails per side.

The 1 in. by 6 in. roof deck was installed perpendicular to the rafters. Each piece of deck was secured to each rafter with two 8d cement coated nails.

The 3 ft wide No. 30 asphalt felt was laid over the 1 in. by 6 in. roof deck with 1/4 in. long staples spaced approximately 16 in OC at the perimeter and in the field. The asphalt felt was overlapped 2 in. at each intersection.

The Class A Asphalt Shingles were installed over the No. 30 asphalt felt with four 1-1/2 in. long electro galvanized roofing nails per sheet. The shingles were installed per the manufacture’s installation instructions and overlapped 4-1/2 in.

The aluminum mushroom vents were installed per the manufacture’s installation instructions with four 1-1/2 long electro galvanized roofing nails per vent. There were three vents installed with the first located over the center rafter cavity and the other two located 40 in. to the North and South of the center cavity. All three vents were located 16 in. West of the ridge beam.

The R-30 attic/flat ceiling glass fiber insulation was installed in the joist cavity with 1/2 in. crown by 1/4 in. long leg staples spread approximately 6 in. to 8 in. OC.

The gypsum board was secured to the exposed side of the assembly with 1-5/8 in. long phosphate coated drywall nails spaced 7 in. OC with nails spaced 1 in from the edge in the field and at the perimeter. The East-West gypsum board joints were staggered 48 in. as to not align any East-West joints. The North-South gypsum board joints were aligned and spaced 48 in. OC. The long edges of the boards were oriented perpendicular to the joists. Two layers of dry mix joint compound was used to cover all gypsum board joints and nails heads.

Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The location of instrumentation within the furnace and on the test sample are shown in Appendix A.

The temperatures of the wood joists were measured with 20 thermocouples. Thermocouple numbers 31-40 were located on the bottom of the joists and thermocouple numbers 41-50 were located on the side of joists mid depth facing North and stapled to the joists.

The temperatures within the interstitial space were measured with 18 thermocouples. Thermocouple numbers 60-68 were located at the center of the interstitial space mid depth. Thermocouple numbers 69-77 were located at the center of the interstitial space on the bottom of the subfloor.

The temperatures between the roof deck and roof felt were measured with 15 thermocouples and numbered 1-15.

The temperatures on top of the roof felt (between the roof felt and asphalt shingles) were measured with 15 thermocouples and numbered 16-30.

The unexposed temperatures were measured with 15 thermocouples and numbered 78-92. Each of the unexposed surface thermocouples was covered with a 6 by 6 in. dry ceramic fiber pad.

The temperatures on top of the mushroom vents was measured with one thermocouple per vent. Thermocouple 93 was located on the North Vent, thermocouple 94 was located on the center vent and thermocouple 95 was located on the South vent.

The temperatures on the unexposed side of the gypsum board (between the gypsum board and the subfloor) were measured with 9 thermocouples and numbered 51-59.

The deflection of the assembly was measured with five electronic transducers.

There were a total of eight camera views taken during the fire exposure period. One camera was positioned in the furnace recording the exposed surface of the assembly, two cameras positioned in the interstitial space between the gypsum board and sub floor. Four other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 51.

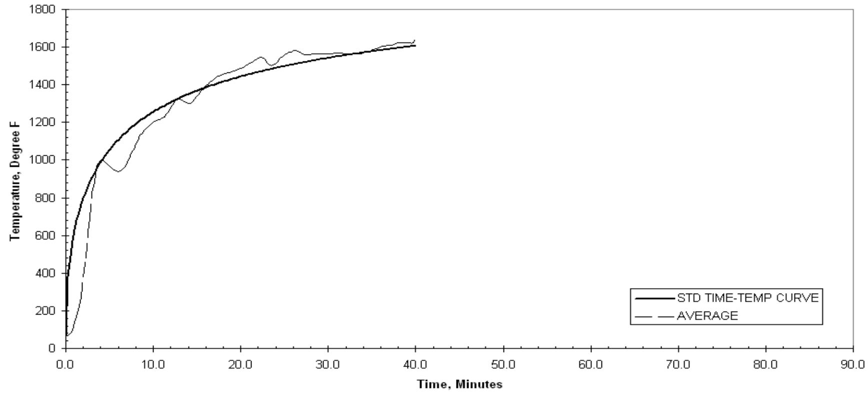


Figure 51 – UL263 Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Assembly No. 7

The furnace pressure and oxygen concentration are presented in Figure 52 and Figure 53.

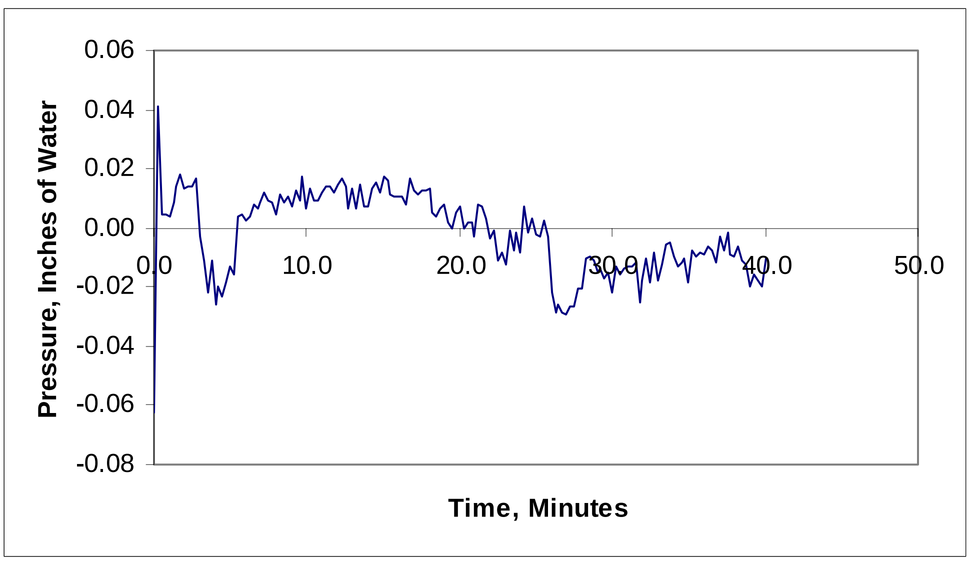


Figure 52 – Furnace Pressure vs. Time for Assembly No. 7

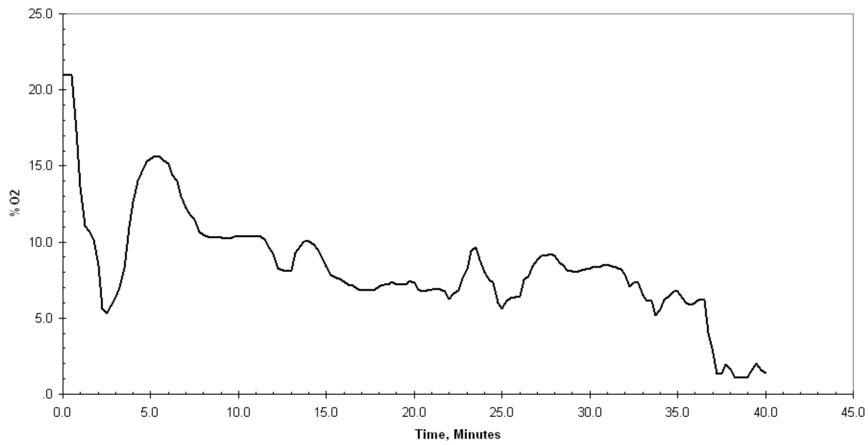


Figure 53 – Oxygen Content vs. Time for Test Assembly No. 7

Observations of the Exposed and Unexposed Surfaces - The following observations were made during the fire test. All references to dimensions are approximate.

Table 10 - Observations for Assembly No. 7

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
2:00	U	Smoke emitted from North vent.
3:00	U	Smoke emitted from all three vents.
4:00	E	Joint tape began to crack.
5:30	E	Joint tape began to peal back.
7:00	U	Smoke at more vent more intense than center and South vents.
7:15	E	Small pieces of joint compound began to fall.
9:00	E	Surface turned gray in color.
11:00	E	30% of joint compound had fallen off.
13:30	E	Flames present at West joint.
14:00	E	Flames present at East joint.
14:00	U	Smoke at vents grew more intense.
14:30	E	70% of joint compound had fallen off.
15:30	E	Cracks were present in gypsum board.
15:45	E	A 2ft by 2ft piece of gypsum board fell followed by a 4ft by 2 ft.
16:00	U	Smoke continued to increase in intensity.
17:00	U	Slight smoke from edge of the assembly.
17:45	E	More smaller sections of gypsum board continued to fall.
18:45	E	Small sections of gypsum board continued to fall.

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
19:00	U	Smoke could be seen from the shingles.
20:15	E	Insulation began to fall
21:00	U	Smoke increased in intensity and cracking could be heard.
21:45	E	Flames present where insulation fell.
22:00	U	Moisture present around vents.
23:00	U	Popping could be heard.
23:30	E	More insulation and gypsum board fell.
25:00	U	Continuous cracking could be heard.
26:00	U	Flaming occurred at North vent and smoke decreased.
27:00	U	Vents displayed puffing of smoke and flaming occurred at center vent.
28:00	U	Smoke became continuous again and flaming was also continuous.
30:00	U	Flaming around vent area. North vent has melted and is open.
32:00	U	Flaming grew in intensity at North vent.
32:15	E	Large pieces of insulation fell.
33:00	E	No visual observations could be made.
33:00	U	Shingles and tar melted around vents.
35:00	U	Kneeling mannequin’s arm began to sink.
38:00	U	Hole grew larger at North vent. Kneeling mannequin fell over. Flaming at kneeling mannequin.
40:00	U/E	Mannequin fell through. Gas off

Temperatures of the Joist - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom of the joists nearest the fire 250°F or the time required to raise the temperature on the bottom of the joists 325°F at any point. The average temperature measured on the bottom of the joists was 70°F before the test. Therefore, the average limiting temperature was 320°F and the individual limiting temperature was 395°F.

The maximum individual limiting temperature for the finish rating was reach at 15 minutes and 15 seconds as recorded by thermocouple number 36. A plot of the finish rating temperatures can be seen on Figure 7.4.

Temperatures at Mid Depth on the Side the Wood Rafters – The average and maximum temperatures of the sides of the wood trusses just before the moment of collapse (40 min 00 sec) were 1375°F and 1476°F respectively. The individual temperature was recorded by thermocouple number 43. A plot of these temperatures can be seen on Figure 7.4.

Temperatures of the Mid Depth Between Wood Joists and Rafters – The average and maximum temperatures of the mid depth between the wood trusses just before the moment of collapse (40 min 00 sec) were 1376°F and 1482°F respectively. The individual temperature was recorded by thermocouple number 63. A plot of these temperatures can be seen on Figure 54.

Temperatures on the Bottom of the Roof Deck Between Wood Joists – The average and maximum temperatures of the sub floor between the wood joists just before the moment of collapse (40 min 00 sec) were 1383°F and 1487°F respectively. The individual temperature was recorded by thermocouple number 72. A plot of these temperatures can be seen on Figure 54

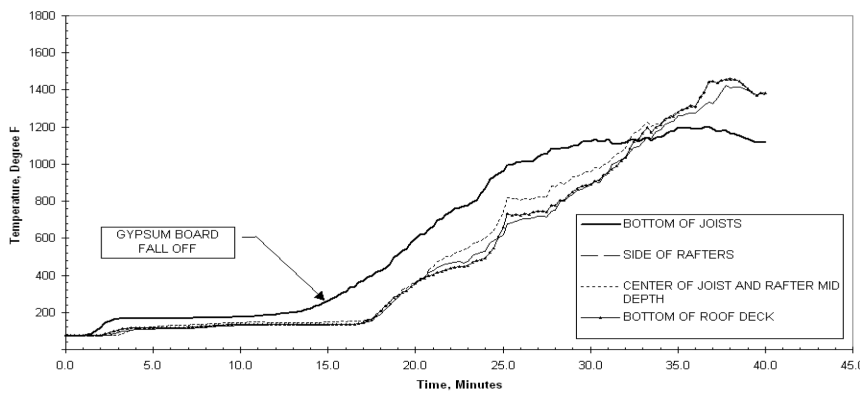


Figure 54 – Plot of Temperatures Below Subfloor vs. Time for Test Assembly No. 7

Temperatures of the Unexposed Side of Gypsum Board – The average and maximum temperatures of the unexposed surface just before the gypsum board fall off (15 min 45 sec) were 253°F and 606°F respectively. The individual temperature was recorded by thermocouple number 58. A plot of these temperatures can be seen on Figure 55

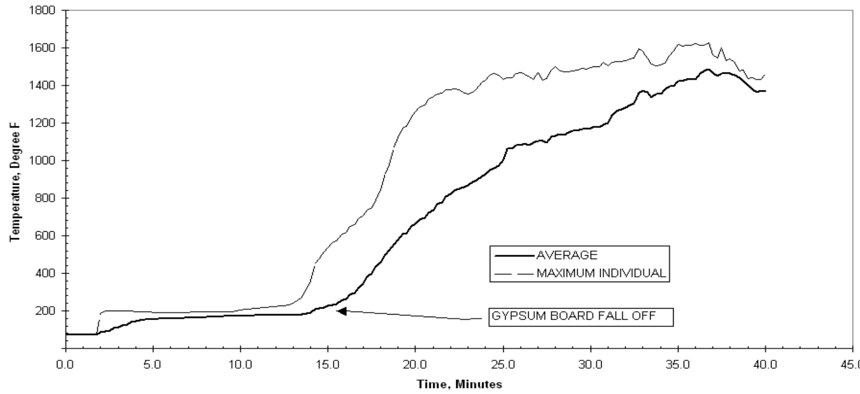


Figure 55 – Plot of Temperature of the Unexposed Surface of Gypsum Board vs. Time for Test Assembly No. 7

Temperatures on the top of the Roof Deck – The average and maximum temperatures between the roof deck and roof felt just before the moment of collapse (40 min 00 sec) were 352°F and 1585°F respectively. The individual temperature was recorded by thermocouple number 4. A plot of these temperatures can be seen on Figure 56.

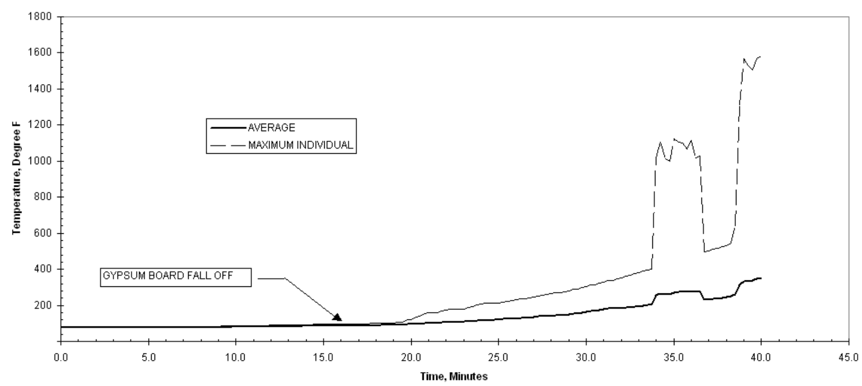


Figure 56 – Plot of the Roof Deck Temperatures vs. Time for Test Assembly No. 7

Temperatures on the Roofing Felt – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (40 min 00 sec) were 303°F and 1129°F respectively. The individual temperature was recorded by thermocouple number 19. A plot of these temperatures can be seen on Figure 57.

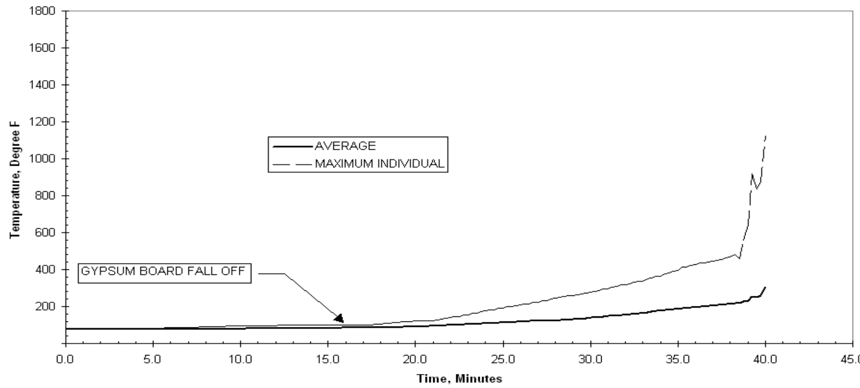


Figure 57 – Plot of Temperature of the Roofing Felt vs. Time for Test Assembly No. 7

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (40 min 00 sec) were 385°F and 1487°F respectively. The individual temperature was recorded by thermocouple number 81. A plot of these temperatures can be seen on Figure 58.

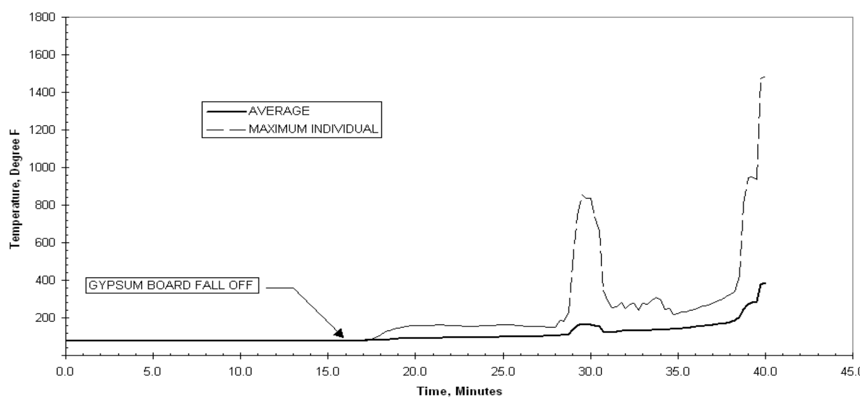


Figure 58 – Plot of Temperatures of the Unexposed Surface vs. Time for Test Assembly No. 7

Temperatures of the Unexposed Surface of the Mushroom Vents – The average and maximum temperatures of the unexposed surface just before the moment of collapse (40 min 00 sec) were 1338°F and 1470°F respectively. The individual temperature was recorded by thermocouple number 94. A plot of these temperatures can be seen on Figure 59.

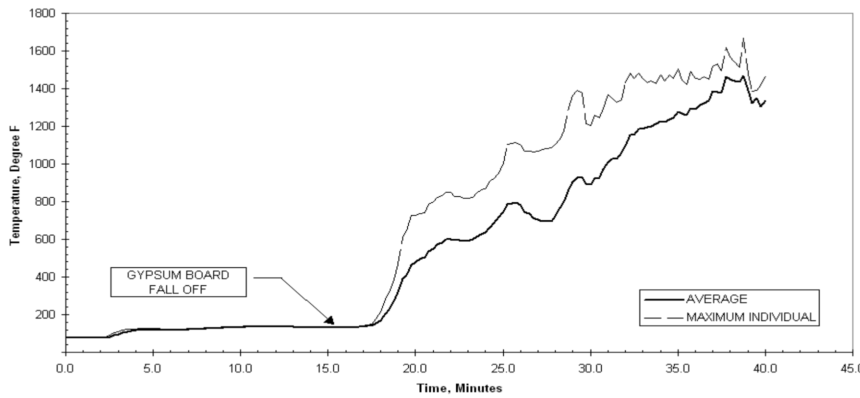


Figure 59 – Plot of Temperatures of the Unexposed Surface of the Mushroom Vent vs. Time for Test Assembly No. 7

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 60. The location of each deflection transducer can be seen in Appendix A under Test Assembly 7.

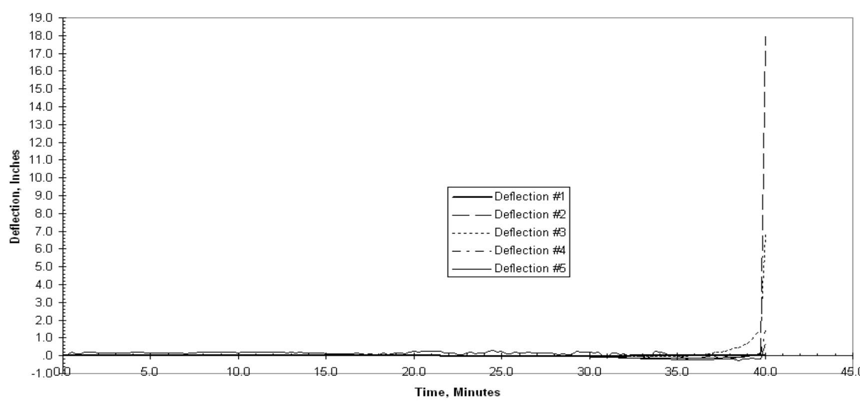


Figure 60 – Plot of Deflections vs. Time for Test Assembly No. 7

Test Record No. 8

Materials

Materials described in section General and used in Assembly No. 3 include 2 in. by 10 in. joists, 2 in. by 6 in. bearing plates, subflooring, red rosin paper and finish flooring. Additional materials are described below.

Cross Bridging – The nominal 1 in. by 3 in. dimensional lumber measured 11/16 in. by 2-7/16 in. and each end was cut at an angle and a length of 16-3/8 in.

Metal Lath – The 3.4 diamond mesh lath measured 8 ft long and 27-1/2 in wide. Each piece weighed approximately 6.25 lbs.

Square Edge Casing Bead – The 10 ft 1 in. long square edge casing bead measured 3/4 in. deep and had a top flange of 1/4 in. wide and a bottom flange of 1 in. The casing measured 0.021 in. thick. Each section weight 1.7 lbs. Holes measuring 3/16 in. in diameter were spaced 1-15/16 in. apart for fastener application.

Plaster – The plaster was applied in three separate coats the base or scratch coat, the middle or brown coat and the finish coat. The mix proportions of each are listed below.

Scratch Coat - The base coat or scratch coat was composed of 100 lbs of gypsum plaster, approximately 1.3 ft^3 of sand, 7 gallons of water and 0.008 ft^3 of calcium sulfate accelerator (approximately 0.2 lbs). The scratch coat had an average wet density of 123 lbs/ft^3.

Brown Coat – The brown coat was composed of 100 lbs of gypsum plaster, 1.8 ft^3 of sand, 7-1/2 gallons of water and 0.008 ft^3 of calcium sulfate accelerator (approximately 0.2 lbs). The brown coat had an average wet density of 122 lbs/ft^3.

Finish Coat – The finish coat was composed of 30.6 lbs of ivory colored autoclaved finish lime, 42.2 lbs of water and 21.9 lbs of red top gauging plaster. The finish coat had an average wet density of 96 lbs/ft^3.

Erection of Test Assembly

Nominal 2 in. by 6 in. structural grade wood bearing plates were placed on top of the steel angles. The 2 in. by 10 in. joists were placed on the wood bearing plates and spaced 16 in. OC starting 8 in. from the East-West centerline of the assembly. The joists were fire stopped with 14-1/2 in. long pieces of nominal 2 by 10 in. lumber. At the North and South ends of the assembly, additional joists, not in the field of the fire for the test, were placed 2-1/2 inches from the North and South edges of the assembly over the vermiculite concrete in order stabilize the nominal 1 by 4 in. tongue and groove subfloor. The average bearing at each end of the joist was 5-1/4 in. The joists were fastened to each bearing plate with two No. 16d coated sinker nails.

The joists were stabilized by nominal 1 by 3 in. bridging cut to lengths of approximately 16-1/2 in. long with their ends cut to an angle of approximately 45 degrees. The pieces of bridging was secured diagonally opposed to each other between each pair of joists with two 6d coated sinker nails at each end of each piece.

The nominal 1 by 6 in. random length tongue and groove subfloor boards were laid diagonally (45 degrees to the joists) and secured in place with No. 8d coated sinker nails four nails per butt joint and two nails in the field at each joist.

The red rosin paper was laid over the subfloor in the East-West direction and secured in place with staples in a random order. There was a 4 in. overlap of each roll of paper.

The nominal 1 by 4 in. tongue and groove finish floor was installed over the building paper and oriented perpendicular to the joists. The finish floor was secured to the joists by 2 in. FLN-200 hardwood flooring nails spaced nominally 8 in. OC nailed through the tongue and groove using an angled flooring nailer.

A bead of fire resistive caulk was placed around the perimeter of the assembly to prevent any flame through between the frame and the test sample.

The perimeter square edge casing bead was secured with 1-1/4 in. long galvanized nails at each joist intersection. The metal lath was installed to the exposed side of the assembly using 1-1/4 in. long galvanized nails. The metal lathe was overlapped 1 in. and secured to each joist with five nails and one nail at each North South overlapping intersection. The metal lath was overlapped 1-1/2 in. at each East West intersection and all overlapping occurred at a joist intersection. The metal lath was wire tied with a single strand of 18 gauge wire tie per intersection. The wire ties were spaced 16 in. OC at each joist cavity.

The three coats of plaster were applied to the metal lath to a final average thickness of 0.79 in.

Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The temperatures of the nominal 2 by 10 in joists were measured with 20 thermocouples. Thermocouple numbers 16-25 were located on the bottom of the joists and thermocouple numbers 26-35 were located on the side of joist mid depth facing North and stapled to the joists.

The temperatures within the interstitial space were measured with 18 thermocouples. Thermocouple numbers 45-53 were located at the center of the interstitial space mid depth and thermocouple numbers 54-62 were located at the center of the interstitial space on the bottom of the sub floor.

The temperatures between the subfloor and finish floor were measured with 15 thermocouples and numbered 1-15.

The temperatures on the back of the metal lath were measured with 9 thermocouples and numbered 36-44.

The temperatures on the unexposed surface were measured with 15 thermocouples and numbered 63-77. Each of the unexposed surface thermocouples was covered with a 6 by 6 in. dry ceramic fiber pad.

The deflection of the assembly was measured with nine electronic transducers.

There were a total of eight camera views taken during the fire exposure period. Two cameras were positioned in the interstitial spaced in the cavities under both the kneeling and standing mannequins, both cameras were facing West. One camera was positioned in the furnace recording the exposed surface of the assembly, one infrared camera recording the unexposed surface temperatures. Four other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 61

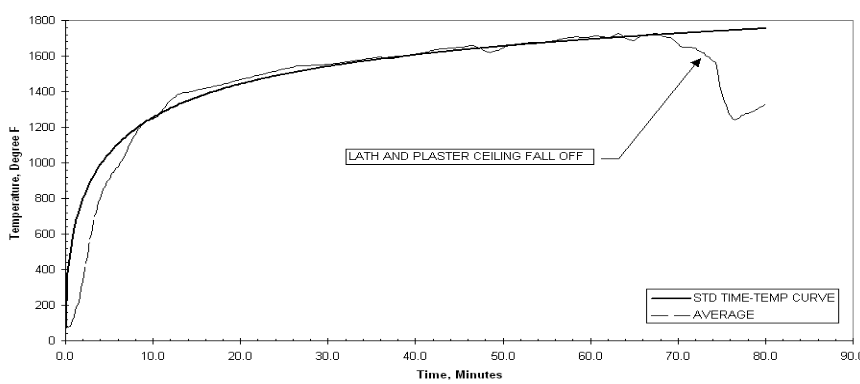


Figure 61 – UL263 Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Test Assembly No. 8

The furnace pressure and oxygen concentration are presented Figure 62 and Figure 63.

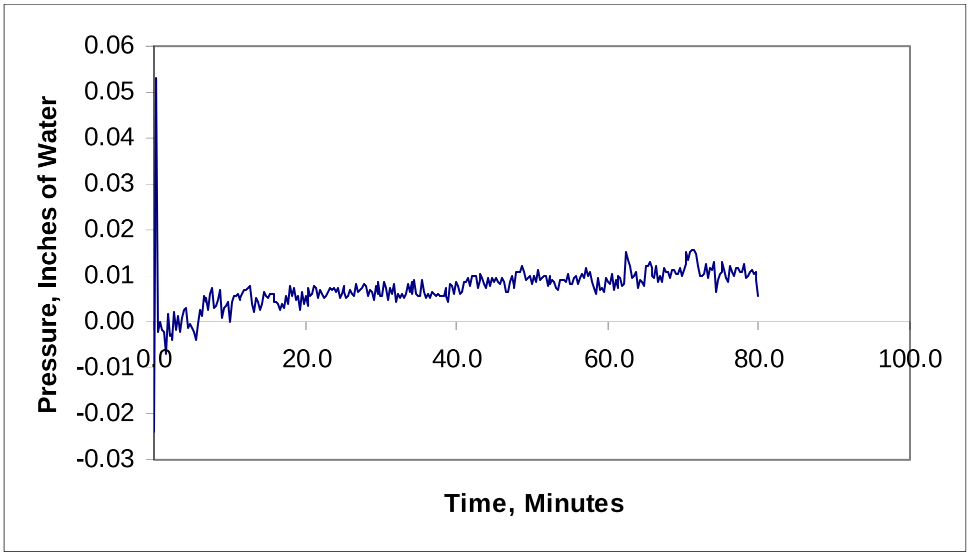


Figure 62 – Furnace Pressure vs. Time for Test Assembly No. 8

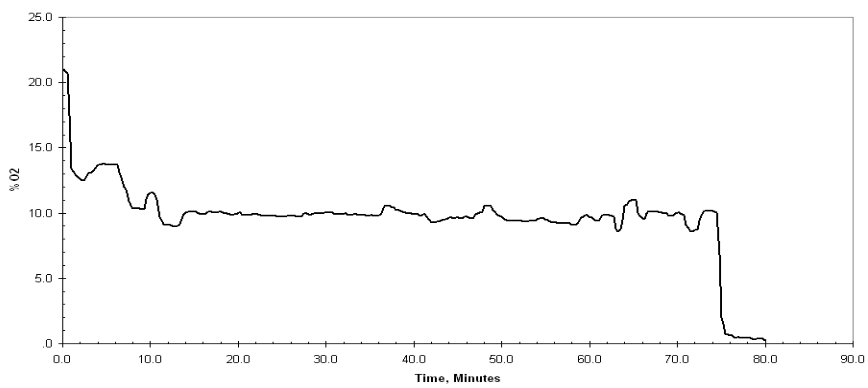


Figure 63 – Oxygen Content vs. Time for Test Assembly No. 8

Observations of the Exposed and Unexposed Surfaces - The observations made during the fire test are presented in Table 11. All references to dimensions are approximate.

Table 11 - Observations for Assembly No. 8

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
2:00-14:00	U	No change.
7:00	E	Discoloration could be seen.
15:30	U	Smoke emitting from North saddle on West edge.
18:00	U	Smoke emitting from both saddles on West edge.
22:00	U	No change.
26:00	U	No change.
26:00	E	No cracking in plaster but discoloration was present.
27:00	E	Thermocouple #13 malfunctioned and was taken out of the furnace average.
30:00	U	No change.
32:00	E	No change.
36:00	U	Smoke increase at west edge. Crackling of joints could be heard.
38:00	U	Crackling continued.
42:00	U	Crackling continued and no other changes.
44:20	U	Some smoke could be seen at joints in flooring.
45:00	E	Cracks appeared quickly.
46:00	E	Ceiling surface deflected quickly almost touching center thermocouple.
46:00	U	No change.
47:30	E	Cracks and deflection slowed.
50:00	U	Crackling continued. Smoke continued from finish floor.
51:10	E	Thermocouples touching ceiling surface.
54:00	E	Smoke issued from cracks.
54:00	U	No change. Very little deflection was noted.
54:45	U	Smoke increased at joints and perimeter of assembly.
58:00	U	No change.
59:00	E	Flames issued from cracks.
60:00	U	Smoke and crackling increase with no visible deflection.
62:00	E	Flame intensity increased and was more pronounced at East West edges.
64:00	E	Furnace windows were closed due to flames.
64:00	U	Smoke increase and less crackling was heard.
65:00	E	Ceiling rested on four furnace thermocouples.
67:30	U	Smoke emitting from most hardwood joints.
68:00	E	Furnace thermocouple #11 fell.
69:00	E	Furnace thermocouple #10 fell. Ceiling rested on one furnace thermocouple.
70:00	U	Smoke continued to increase with no visible deflection.
73:00	E	Furnace thermocouple #12 fell.
74:00	E	Ceiling fell and destroyed all furnace thermocouples.
74:00	U	Smoke decreased.

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
76:00	U	Floor deflected about 1 in.
78:30	U	Floor deflected about 2 in.
79:45	E	Mannequin fall through. Gas off.

Temperatures of the Wood Joists - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom surface nearest the fire 250°F or the time required to raise the temperature on the bottom surface 325°F at any point. The average temperature measured on the bottom surface of the joists was 75°F before the test. Therefore, the average limiting temperature was 325°F and the individual limiting temperature was 400°F.

The average limiting temperature for the finish rating was reach at 17 minutes as recorded by the average of thermocouple numbers 16-25.

Temperatures of the Side of Mid Depth of Wood Joists – The average and maximum temperatures of the sides of the wood joists just before the moment of collapse (79 min 45 sec) were 1395°F and 1483°F respectively. The individual temperature was recorded by thermocouple number 27. The average temperatures were plotted on Figure 64.

Temperatures of the Mid Depth Between Wood Joists – The average and maximum temperatures of the mid depth between the wood joists just before the moment of collapse (79 min 45 sec) were 1403°F and 1466°F respectively. The individual temperature was recorded by thermocouple number 46. The average temperatures were plotted on Figure 64.

Temperatures of the Sub Floor Between Wood Joists **–** The average and maximum temperatures of the sub floor between the wood joists just before the moment of collapse (79 min 45 sec) were 1402°F and 1464°F respectively. The individual temperature was recorded by thermocouple number 55. The average temperatures were plotted on Figure 64.

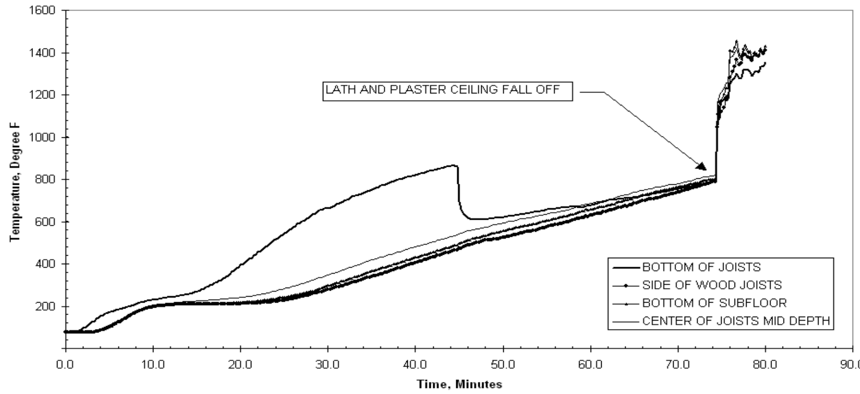


Figure 64 – Plot of Temperatures Below Subfloor vs. Time for Test Assembly No. 8

Temperatures on the Back of the Metal Lath – The average and maximum temperatures on the back of the metal lath just before the lath and plaster ceiling fall off (74 min) were 1109°F and 1259°F respectively. The individual temperature was recorded by thermocouple number 38. The average temperatures were plotted on Figure 65.

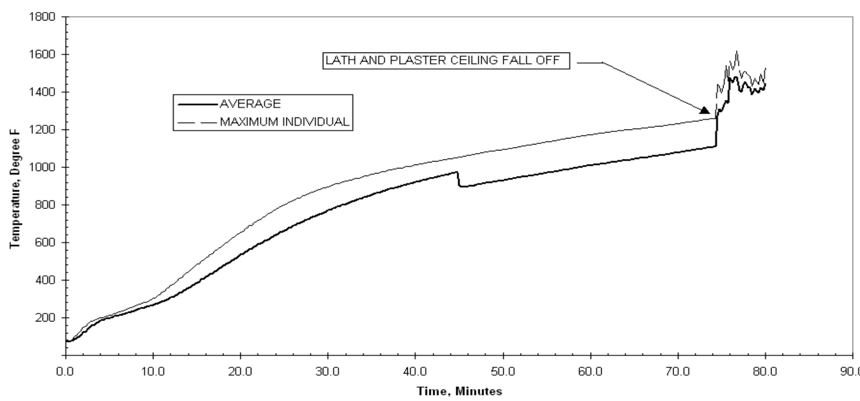


Figure 65 – Plot of Temperature of the Back of the Metal Lath vs. Time for Test Assembly No. 8

Temperatures of Between the Sub Floor and Finish Floor – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (79 min 45 sec) were 430°F and 777°F respectively. The individual temperature was recorded by thermocouple number 4. The average temperatures were plotted on Figure 66.

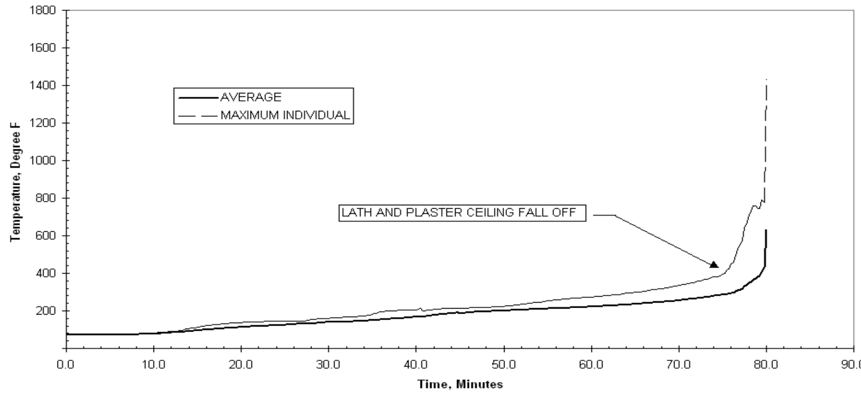


Figure 66 – Plot of Temperature of the Subfloor Temperatures vs. Time for Test Assembly No. 8

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (79 min 45 sec) were 174°F and 197°F respectively. The individual temperature was recorded by thermocouple number 65. The average temperatures were plotted on Figure 67.

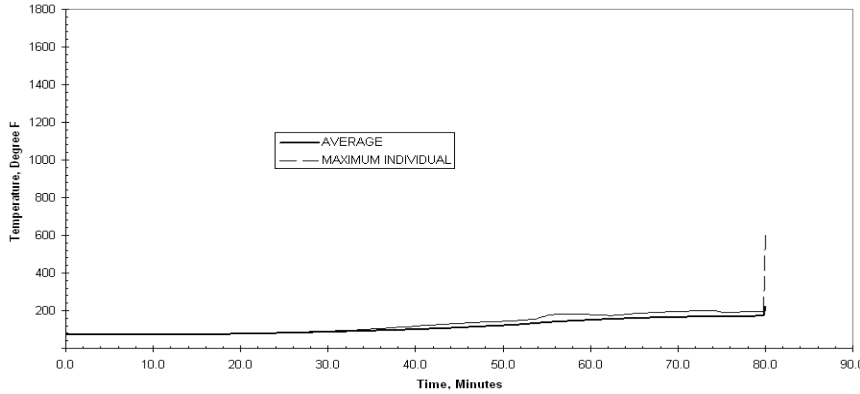


Figure 67 – Plot of Temperatures of the Unexposed Surface vs. Time for Test Assembly No. 8

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 68. The location of each deflection transducer can be seen in Appendix A under Test Assembly 8.

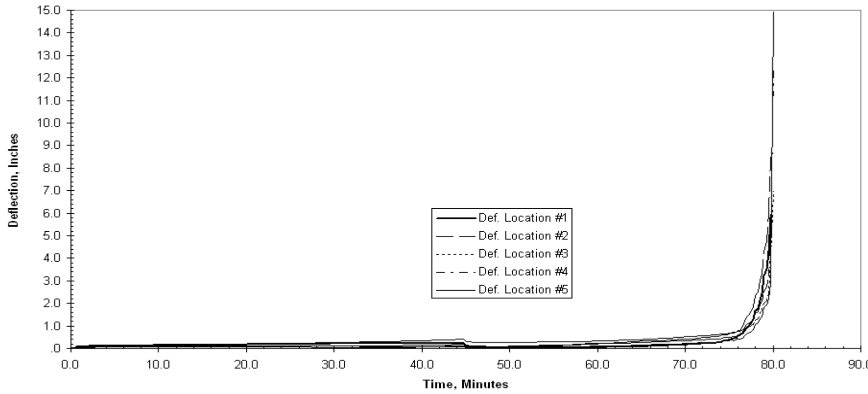


Figure 68 – Plot of Deflections vs. Time for Test Assembly No. 8

Test Record No. 9

Materials

Materials described in section General and used in Assembly No. 7 include engineered 2 by 4 bearing plate, No. 30 asphalt felt, faced batt insulation, gypsum board and Class A asphalt shingles. Additional materials are described below.

Metal Gusseted Trusses – The roof trusses were 20 in. deep at the peak, 13 ft 10 in. long and fabricated from nominal 2 in. by 4 in. wood members. The roof truss had an average weight of 36.78 lb. The nominal 4 in. side of the truss members was oriented in the vertical direction. The truss members were secured together with galvanized steel plates measuring 0.036 in. thick for 1.5 in. by 4 in., 4 in. by 4 in., 4 in. by 5 in. and 4 in. by 7 in. sizes. The plates contained 5/16 in. long teeth projecting perpendicular to the plane of the plate. The moisture content of the truss members ranged from 6.1 to 7.2 percent and averaged 6.6 percent.

Blocking – The nominal 2 in. by 8 in dimensional lumber was cut to fit the area at the end of each joist. The installed pieces measured 1-1/2 in. by 6-1/8 in.

Roof Deck – The nominal 7/16 in. thick oriented strand board roof deck measured an average of 0.45 in. thick and weighed an average of 41.54 lbs per sheet. The panels were supplied in 48 in. wide by 96 in. long panels.

Plywood Clips – The 7/16 in. high steel plywood clips measured 0.036 in. thick. The clip was arranged in a double C channel orientation. The C channels were back to back and one side measured 1-1/2 in. wide and the other measured 1/2 in. wide with the smaller side cut from the larger side.

Ridge Vent – The non-metallic ridge vents measured 13-7/8 in. wide by 4 ft long. The vents had an overall thickness of 1-1/2 in. at the center and 1 in. at the edges. Each edge of the vent contained a grid to allow the movement of air. The underside of the vent contained a filter screen. Nail holes spaced 12 in. OC with holes spaced 3-1/4 in. from the edge were present to accommodate the attachment of the vents to the roof deck.

Erection of Test Assembly

Nominal 2 in. by 6 in. structural grade wood bearing plates were placed on top of the steel angles. The metal gusseted wood trusses were placed on the wood bearing plates and spaced 24 in. OC starting at the East West centerline of the assembly. At the North and South ends of the assembly, additional trusses, not in the field of the fire test, were placed over the vermiculite concrete in order stabilize the roof assembly. The trusses were fastened to each bearing plate with two No. 16d nails. The trusses were fire-stopped with nominal 2 in. by 8 in. lumber which was cut to fit.

The far most North and South trusses were reinforced with 7/16 in. thick OSB nailed to the outside of the trusses with 8d nails spaced 6 in. OC at the perimeter and on the web members.

The 7/16 in. thick OSB roof deck was laid on top of the roof trusses. The panels were staggered 48 in. in the East West direction. In the North South direction the plywood joints were aligned and located 48 in. off the East and West edges. Plywood clips were installed 24 in. OC starting 12 in. off the center truss. The clips were only placed on the joints running in the North South direction. A 3-1/4 in. gap was left at the crest of the roof system to allow for the application of the ridge vent. The deck was attached to the trusses using 1-7/8 in. long ringshank nails space 12 in. OC in the field and 6 in. at the perimeter.

The 3 ft wide No. 30 asphalt felt was laid over the 7/16 in. OSB roof deck with 1/4 in. long staples spaced approximately 8 to 10 in. OC at the perimeter and in the field. The asphalt felt was overlapped 2 in. at each intersection.

The Class A Asphalt Shingles were installed over the No. 30 asphalt felt with four 1-1/2 in. long electro galvanized roofing nails per sheet. The shingles were installed per the manufacture’s installation instructions and overlapped 4-1/2 in.

The non-metallic ridge vent was installed at the crest of the assembly per the manufacture’s installation instructions with ten 16d nails per 48 in. long vent. There were four vents installed located the entire North South length of the assembly.

The R-30 attic/flat ceiling glass fiber insulation was installed in the truss cavity with 1/2 in. crown by 1/4 in. long leg staples spread approximately 6 in. to 8 in. apart.

The gypsum board was secured to the exposed side of the assembly with 1-5/8 in. long phosphate coated drywall nails spaced 7 in. OC with nails spaced 1 in from the edge in the field and at the perimeter. The East-West gypsum board joints were staggered 48 in. as to not align any East-West joints. The North-South gypsum board joints were aligned and spaced 48 in. OC. The long edges of the boards were oriented perpendicular to the joists. Two layers of dry mix joint compound was used to cover all gypsum board joints and nails heads.

Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The temperatures of the wood trusses were measured with 20 thermocouples. Thermocouple numbers 31-40 were located on the bottom of the trusses and thermocouple numbers 41-50 were located on the side of trusses mid depth facing North and stapled to the trusses.

The temperatures on the unexposed side of the gypsum board (between the gypsum board and the subfloor) were measured with 10 thermocouples and numbered 51-60.

The temperatures within the interstitial space were measured with 20 thermocouples. Thermocouple numbers 61-70 were located at the center of the interstitial space mid depth. Thermocouple numbers 71-80 were located at the center of the interstitial space on the bottom of the roof deck.

The temperatures between the roof deck and roof felt were measured with 15 thermocouples and numbered 1-15.

The temperatures on top of the roof felt (between the roof felt and asphalt shingles) were measured with 15 thermocouples and numbered 16-30.

The unexposed temperatures were measured with 13 thermocouples and numbered 81-93. Each of the unexposed surface thermocouples was covered with a 6 by 6 in. dry ceramic fiber pad.

The deflection of the assembly was measured with five electronic transducers.

There were a total of eight camera views taken during the fire exposure period. One camera was positioned in the furnace recording the exposed surface of the assembly, two cameras positioned in the interstitial space between the gypsum board and sub floor. Four other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 69.

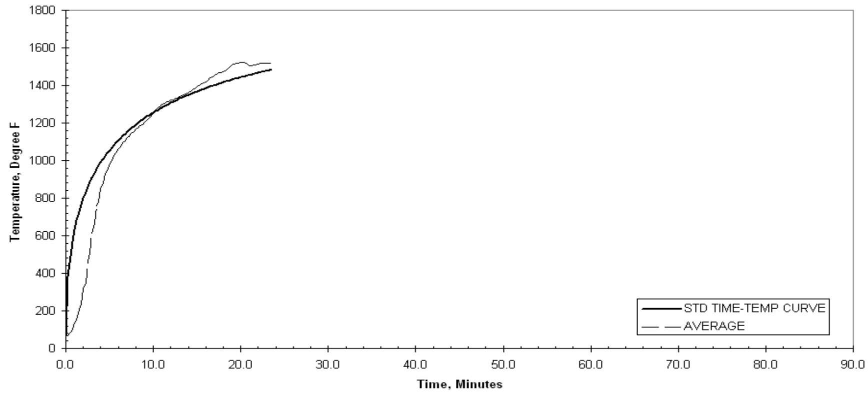


Figure 69 – UL263 Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Test Assembly No. 9

The furnace pressure and oxygen concentration are presented in Figure 70 and Figure 71.

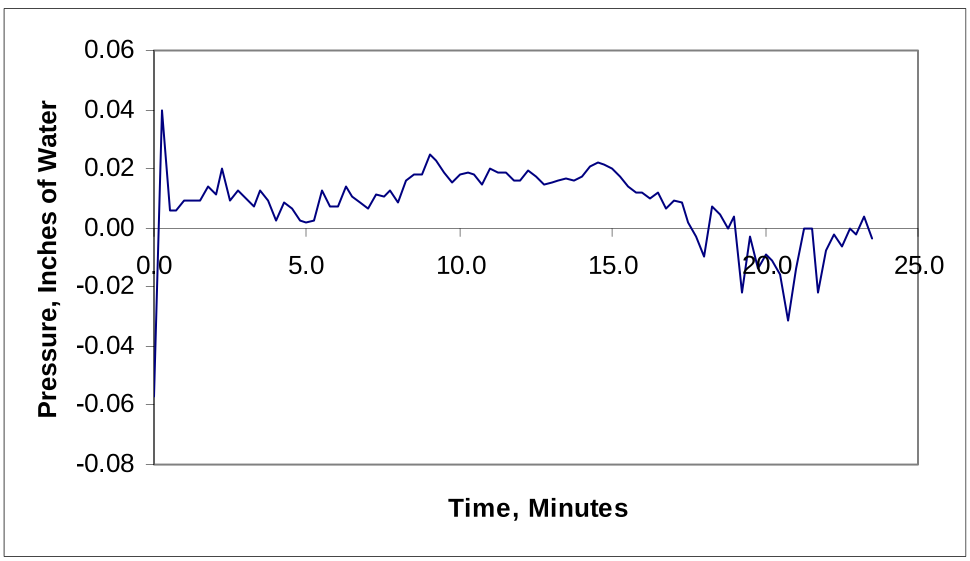


Figure 70 – Furnace Pressure vs. Time for Test Assembly No. 9

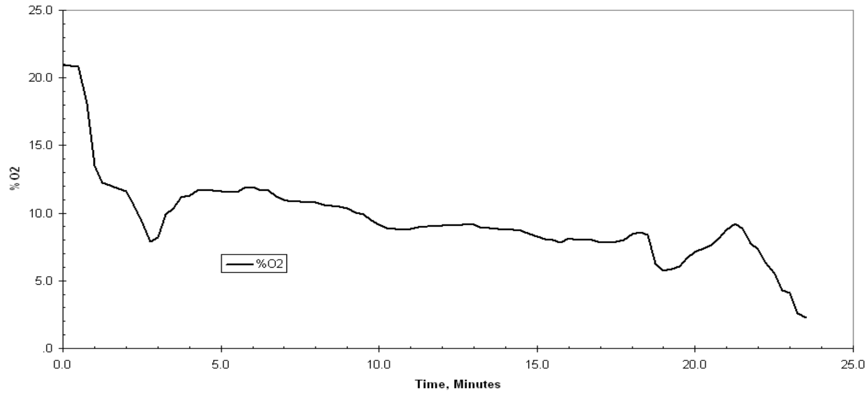


Figure 71 – Oxygen Content vs. Time for Test Assembly No. 9

Observations of the Exposed and Unexposed Surfaces - The observations made during the fire test are presented in Table 12. All references to dimensions are approximate.

Table 12 - Observations for Assembly No. 9

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
1:00	E	Paper surface turned dark in color.
1:30	E	Paper surface ignited.
2:00	U	Smoke at perimeter. Mainly at gable ends.
3:00	U	Smoke emitted from entire length of roof vent.
3:30	E	Surface turned black and charred
3:45	E	Joint compound began to crack.
4:15	U	Smoke was only present at ridge vent.
6:00	E	Surface turned gray in color.
6:30	U	Smoke emitted at ridge vent and gable ends.
6:30	E	Joint compound began to fall off.
7:30	E	Joint tape and compound continued to fall
9:00	U	No change.
9:00	E	Large pieces of joint compound fell off.
11:30	U	No change.
13:30	U	Smoke increased especially at ridge vent.
13:30	E	Flames could be seen from joints.
13:45	E	Pieces of gypsum board began to fall off.
14:30	E	Pieces of gypsum board continued to fall.
15:00	U	Smoke continued to increase at ridge vent.
16:00	U	Crackling of wood could be heard. Ridge vent deformed near center of assembly.
17:00	U	Really thick smoke could be seen at ridge vent.
17:15	E	Insulation fell out allowing direct path to attic space.

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
18:30	U	Crackling of wood could still be heard. Less smoke at center than North and South.
19:00	E	No visual observations could be seen.
21:30	U	Deformation in sheathing between trusses near mannequin locations.
22:30	U	Significant deformation at kneeling mannequin.
23:00	U	Flame through.
23:10		Kneeling mannequin fell through.
23:15	U/E	Mannequin fell through. Gas off.

Temperatures of the Trusses - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom of the trusses nearest the fire 250°F or the time required to raise the temperature on the bottom of the trusses 325°F at any point. The average temperature measured on the bottom of the trusses was 68°F before the test. Therefore, the average limiting temperature was 318°F and the individual limiting temperature was 393°F.

The maximum individual limiting temperature for the finish rating was reach at 14 minutes and 45 seconds as recorded by thermocouple number 40. A plot of the finish rating temperatures can be seen on Figure 9.4.

Temperatures at Mid Depth on the Side the Trusses – The average and maximum temperatures of the sides of the wood trusses just before the moment of collapse (23 min 15 sec) were 1061°F and 1432°F respectively. The individual temperature was recorded by thermocouple number 46. A plot of these temperatures can be seen on Figure 72.

Temperatures of the Mid Depth Between Wood Trusses – The average and maximum temperatures of the mid depth between the wood trusses just before the moment of collapse (23 min 15 sec) were 1255°F and 1500°F respectively. The individual temperature was recorded by thermocouple number 64. A plot of these temperatures can be seen on Figure 72.

Temperatures on the Bottom of the Roof Deck Between Wood Trusses – The average and maximum temperatures of the sub floor between the wood joists just before the moment of collapse (23 min 15 sec) were 1206°F and 1499°F respectively. The individual temperature was recorded by thermocouple number 74. A plot of these temperatures can be seen on Figure 72.

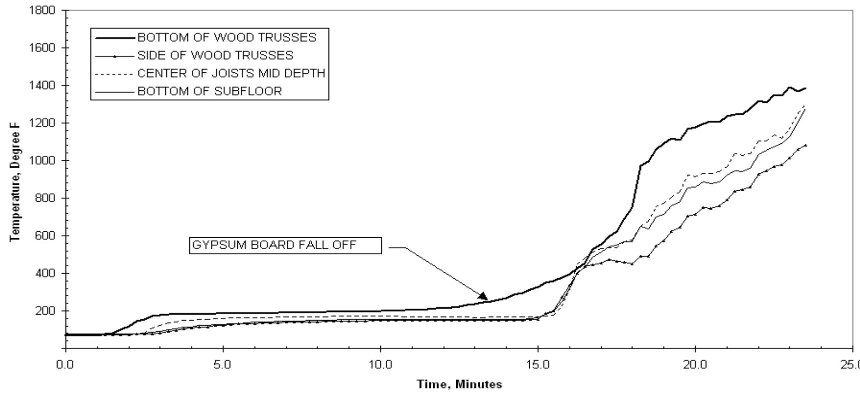


Figure 72 – Plot of Temperature Below Subfloor vs. Time

Temperatures of the Unexposed Side of Gypsum Board – The average and maximum temperatures of the unexposed surface just before the gypsum board fall off (13 min 45 sec) were 731°F and 1033°F respectively. The individual temperature was recorded by thermocouple number 56. A plot of these temperatures can be seen on `Figure 73`

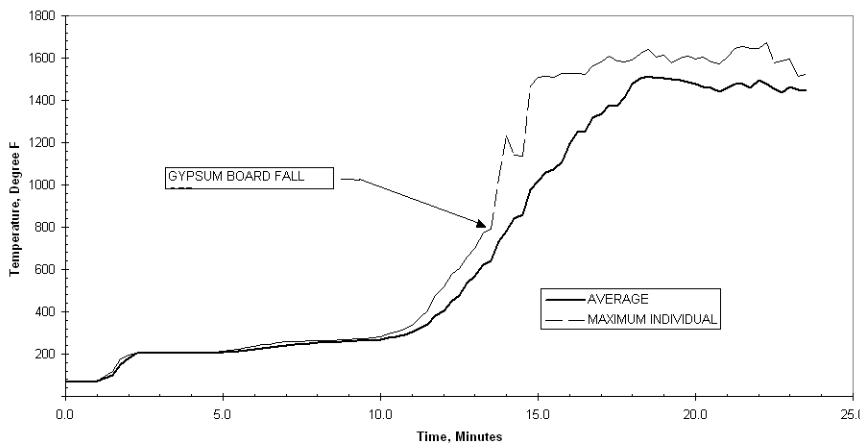


Figure 73 – Plot of Temperature of the Unexposed Surface of Gypsum Board vs. Time

Temperatures on the Top of the Roof Deck – The average and maximum temperatures between the roof deck and roof felt just before the moment of collapse (23 min 15 sec) were 249°F and 723°F respectively. The individual temperature was recorded by thermocouple number 9. A plot of these temperatures can be seen on Figure 9.6.

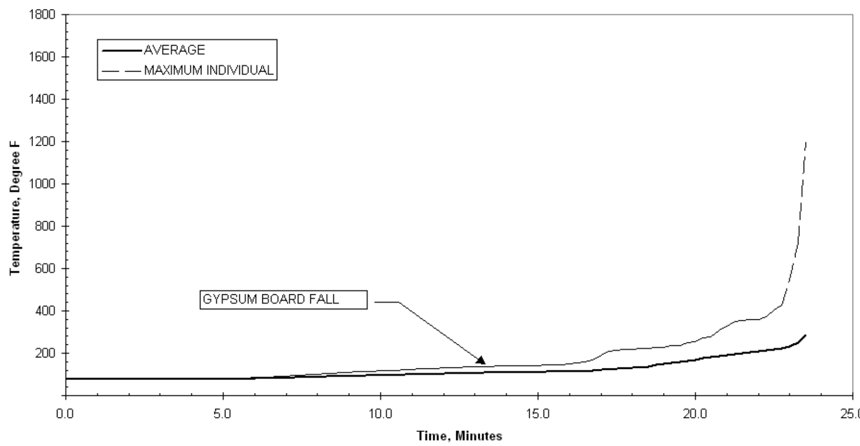


Figure 9.6 – Plot of Temperature of the Roof Deck Temperatures vs. Time

Temperatures on the Roofing Felt – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (23 min 15 sec) were 182°F and 245°F respectively. The individual temperature was recorded by thermocouple number 23. A plot of these temperatures can be seen on Figure 9.7.

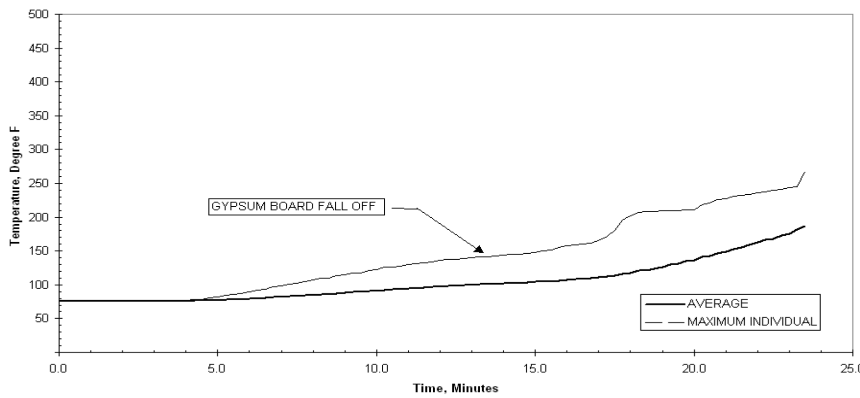


Figure 74 – Plot of Temperature of the Roofing Felt vs. Time

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (23 min 15 sec) were 138°F and 263°F respectively. The individual temperature was recorded by thermocouple number 92. A plot of these temperatures can be seen on Figure 75.

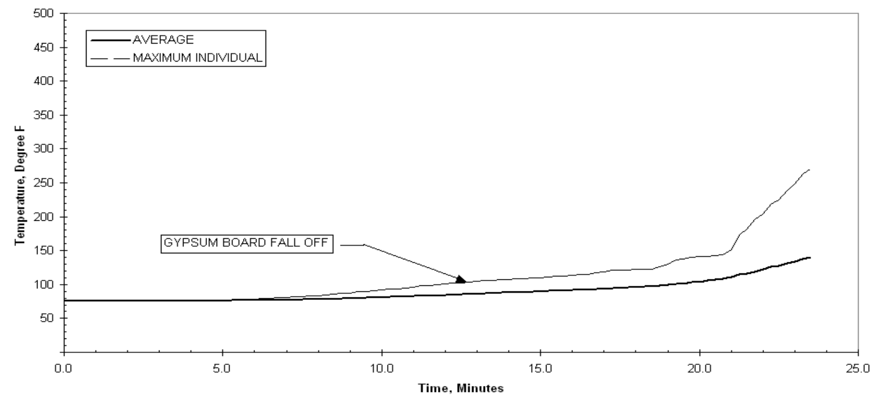


Figure 75 – Plot of Temperatures of the Unexposed Surface vs. Time

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 9.9. The location of each deflection transducer can be seen in Appendix A under Figure 76.

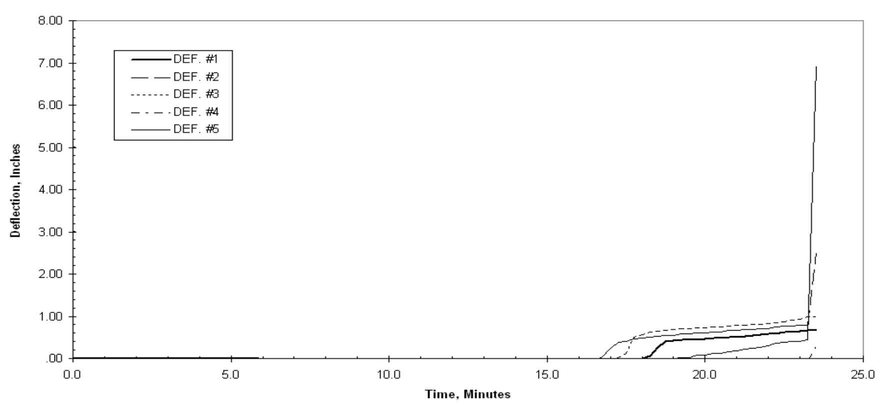


Figure 76 – Plot of Deflections vs. Time

Discussion

Furnace Conditions

The average temperature within the furnace, the pressure within the furnace and the percent oxygen content in the furnace exhaust duct were plotted in Figure 77, Figure 78 and Figure 79, respectively.

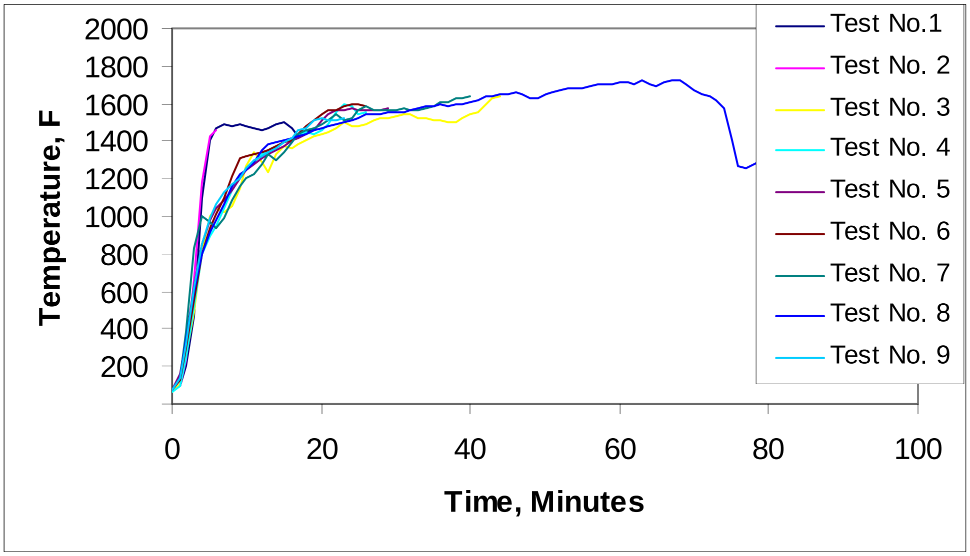


Figure 77 - Furnace Temperature

The furnace temperature during the initial portion of Test Nos. 1 and 2 were significantly higher than recorded during Test Nos. 3 through 9 because the combustible supports and sub-floors for both of these assemblies were exposed to the furnace fire at the start of the test. The relatively low furnace temperatures recorded during the later stages of Test No. 8 reflect the collapse of the plaster ceiling upon the thermocouples in the furnace.

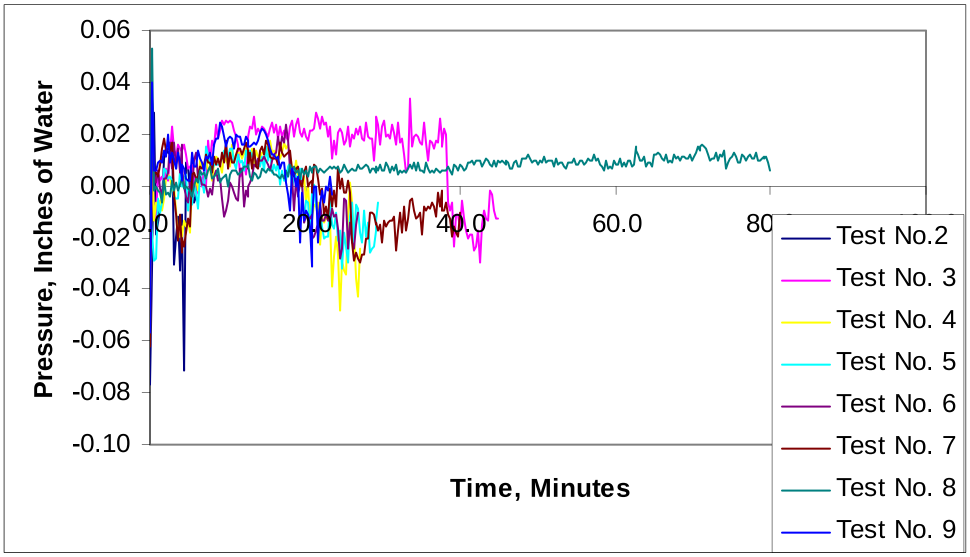


Figure 78 - Furnace Pressure

The furnace pressure was measured at a level approximately 4 inches below the ceiling surface. After the initial few minutes, the furnace pressure ranged from 0.01 to 0.02 inches of water until the ceiling fell. Then the furnace pressure became negative and ranged for 0.01 to 0.03 inches of water.

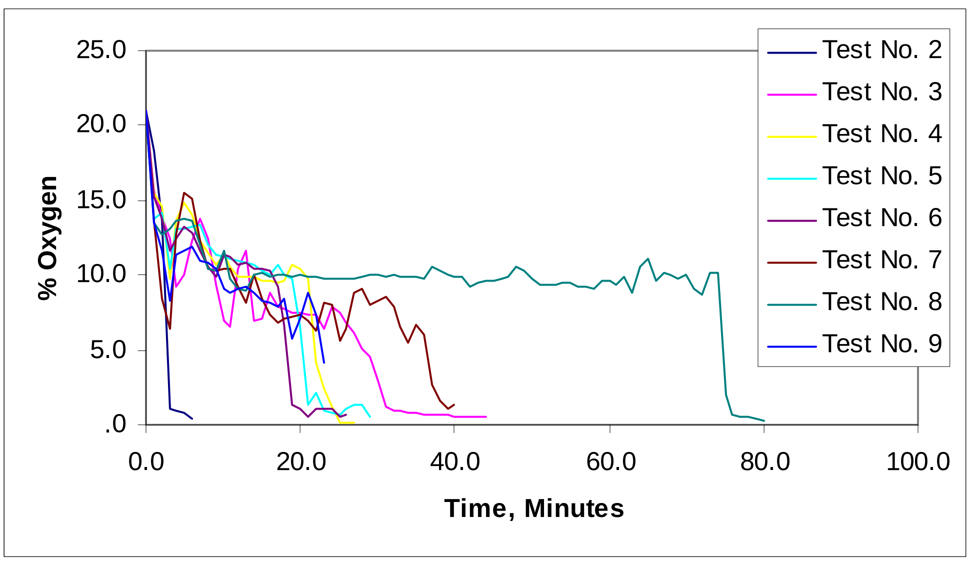


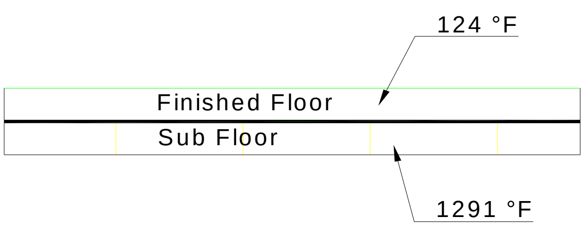
Figure 79 - Percent Oxygen in Furnace

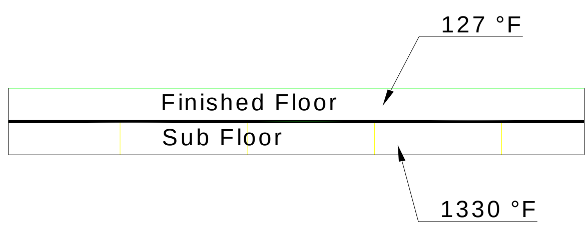
The percent oxygen content at the beginning of the tests was approximately 19 to 20 percent and was reduced to approximately 6 to 8 percent during the tests when the ceilings were in place. The percent oxygen content dropped to near zero after the ceilings fell and the combustible supports and sub-floor were exposed to the furnace flames.

Overall, the conditions within the furnace during each of the nine fire tests were sufficiently similar to enable a comparison of the structural performance of the samples when considering the state of the test samples.

Floor and Roof Surface Temperature Conditions

The use of thermal imaging cameras by firefighters continues to grow and has many current and potential life safety applications. The temperature on the surfaces of the floor and roof were measured at several locations during each fire test. The temperatures of these surfaces at 60 seconds and at 30 seconds before collapse are shown in Figure 80 to Figure 88.

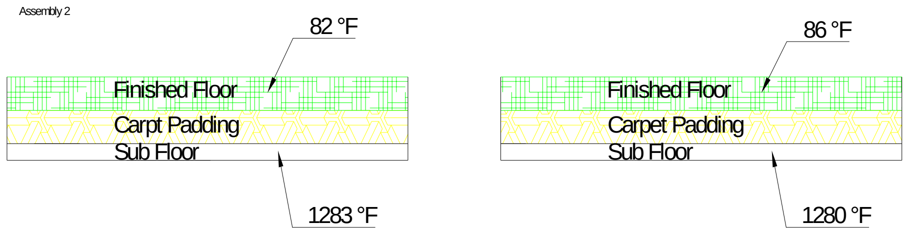




60 seconds before collapse 30 seconds before collapse

Collapse at 18 min.: 45 sec.

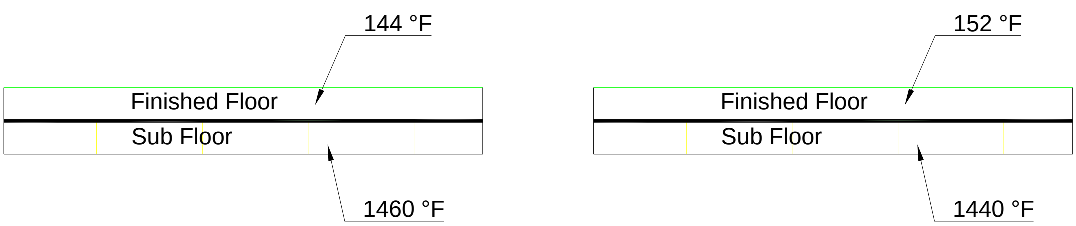
Figure 80 -Test Assembly No. 1



60 seconds before collapse 30 seconds before collapse

Collapse at 6 min.: 3 sec.

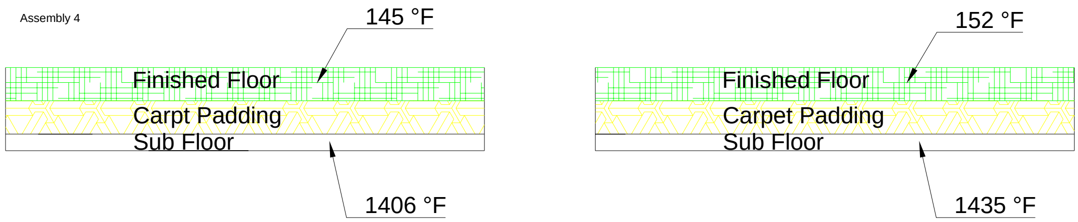
Figure 81- Test Assembly No. 2



60 seconds before collapse 30 seconds before collapse

Collapse at 44 min.: 45 sec.

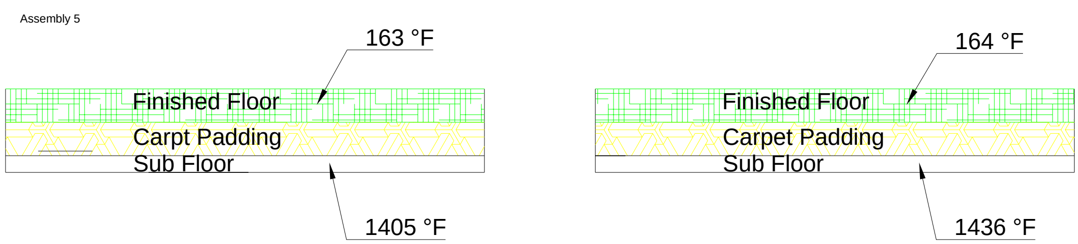
Figure 82 - Test Assembly No. 3



60 seconds before collapse 30 seconds before collapse

Collapse at 26 min.: 45 sec.

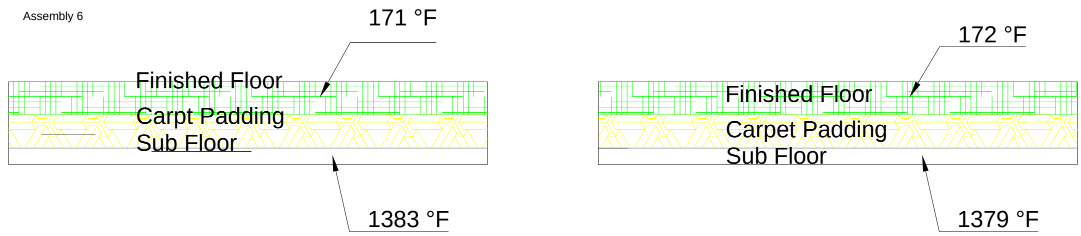
Figure 83 - Test Assembly No. 4



60 seconds before collapse 30 seconds before collapse

Collapse at 29 min.: 15 sec.

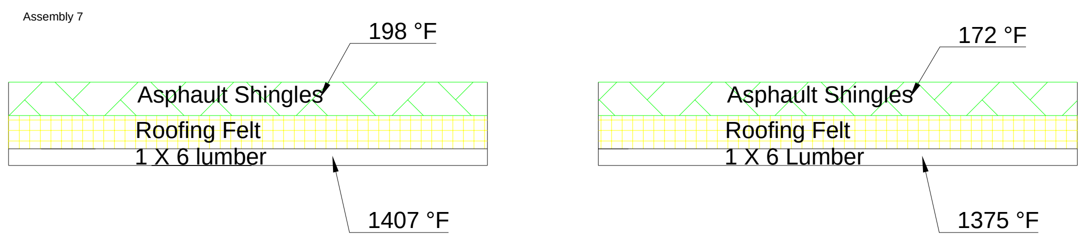
Figure 84 - Test Assembly No. 5



60 seconds before collapse 30 seconds before collapse

Collapse at 26 min.: 45 sec.

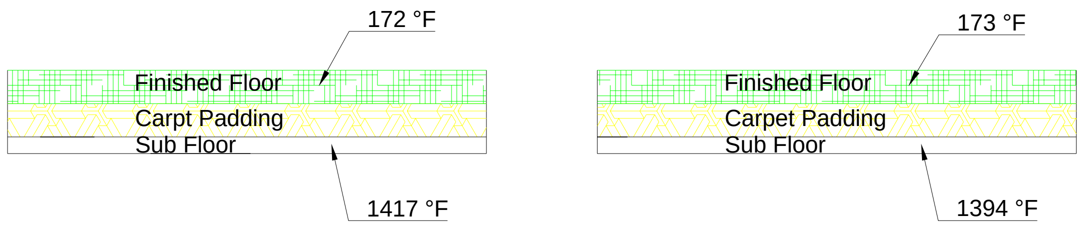
Figure 85 - Test Assembly No. 6



60 seconds before collapse 30 seconds before collapse

Collapse at 40 min.

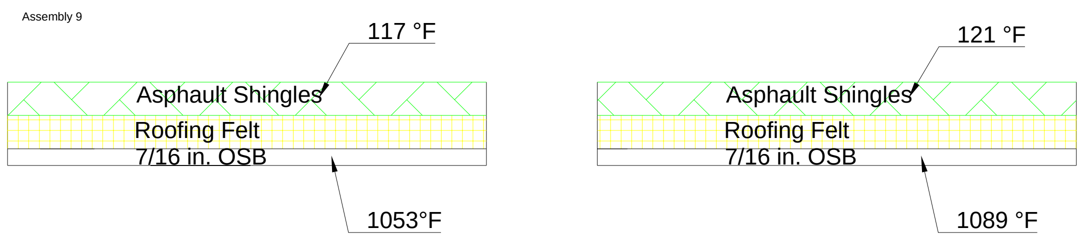
Figure 86 - Test Assembly No. 7



60 seconds before collapse 30 seconds before collapse

Collapse at 79 min.: 45 sec.

Figure 87 - Test Assembly No. 8



60 seconds before collapse 30 seconds before collapse

Collapse at 23 min.: 15 sec.

Figure 88 - Test Assembly No. 9

Table 15 provides a summary of the temperature date in the previous Figure 80 through Figure 88.

Table 13 - Average temperature on exposed surface of sub-floor or roof deck and average temperature on unexposed surface of floor or roofing shingles.

Assembly No.	Average temperature of exposed (lower) surface of sub-floor or roof deck 30 seconds before collapse (ºF)	Average temperature of unexposed (upper) surface of floor or asphalt shingles 30 second before collapse (ºF)
1	1330	127
2	1280	86
3	1440	147
4	1435	152
5	1436	164
6	1379	172
7	1375	204
8	1394	173
9	1089	121

It should be noted the relatively low temperatures on the surface viewed by the thermal imaging camera shortly before collapse as compared to the surface temperature of the sub-floor exposed to the fire.

Structural Serviceability

Firefighters have expressed concern about the rate of structure's deflection prior to collapse when reporting on experiences upon entering a fire scene and performing life safety and fire extinguishment activities. The firefighters' reports indicate the lightweight wood construction collapses at a quicker rate as compare to floors supported by 2 by 10s.

Reviewing data from Test Nos. 1 and 2 support this observation. The elapse time between the start of a continuous deflection and collapse was 13 minutes for Sample No. 1 (2 by 10s without a ceiling) and 3 minutes for Sample No. 2 (wood I joist without a ceiling). The elapse time increased when a gypsum board ceiling was installed beneath the I joist supports. The elapse time increased to 6 minutes from 3 minutes for the I joist sample with the gypsum board ceiling. For the two samples with 2 by 4 wood trusses the elapse time was 10 minutes and 7 minutes for Sample Nos. 5 and 6, respectively.

Summary of Findings

The project included the fire testing of nine combustible assemblies with the intent of documenting the significantg differences, if any, in the performance of these assemblies with respect to fire containment.

Key findings included:

- The fire containment performance of a combustible floor-ceiling assembly representing typical legacy construction without a ceiling was 18 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This performance was defined as the bench mark performance for comparison purposes.

- The fire containment performance of a combustible floor-ceiling assembly supported by engineered I joists was 14 minutes less than the bench mark performance.

- The fire containment performance of the combustible floor-ceiling assembly supported by engineered I joists with a ½ inch thick regular gypsum board ceiling exceeded the bench mark performance by 7 minutes.

- The fire containment performance of a combustible floor-ceiling assembly supported by either: (1) engineered I joists, (2) parallel chord trusses with steel gusset plate connections or (3) parallel chord trusses with glued connections were approximately equal when a ceiling consisting of ½ inch thick regular gypsum wallboard was provided.

In addition, it was noted that the temperature difference between the surface of a floor or roof covering away from the fire and the temperature of the sub-floor or the roof deck below the roof covering ranged from 968 °F to 1221 °F 30 seconds before collapse.

Appendix A – Location of Instrumentation

The location of instrumentation and materials such as thermocouples, deflection transducers, accelerometers, camera locations, joist and truss members, subflooring and finish flooring, and loading conditions are described in this Appendix.

General

Furnace Thermocouples – There were a total of 16 furnace thermocouples space symmetrically throughout the furnace in rows of four.

Assembly No. 1:

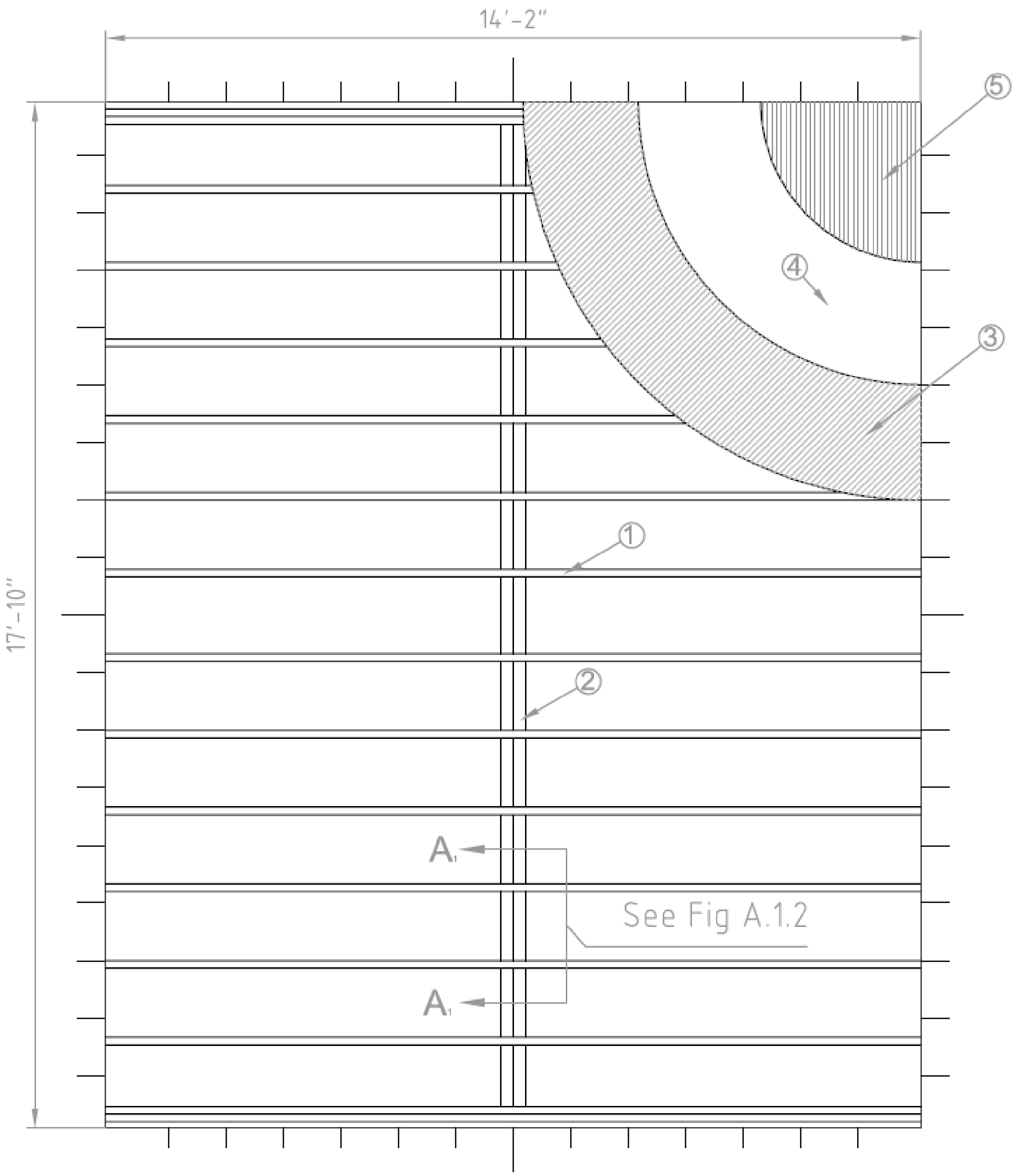


Figure A.1.1 – Construction Layout.

Assembly No. 1

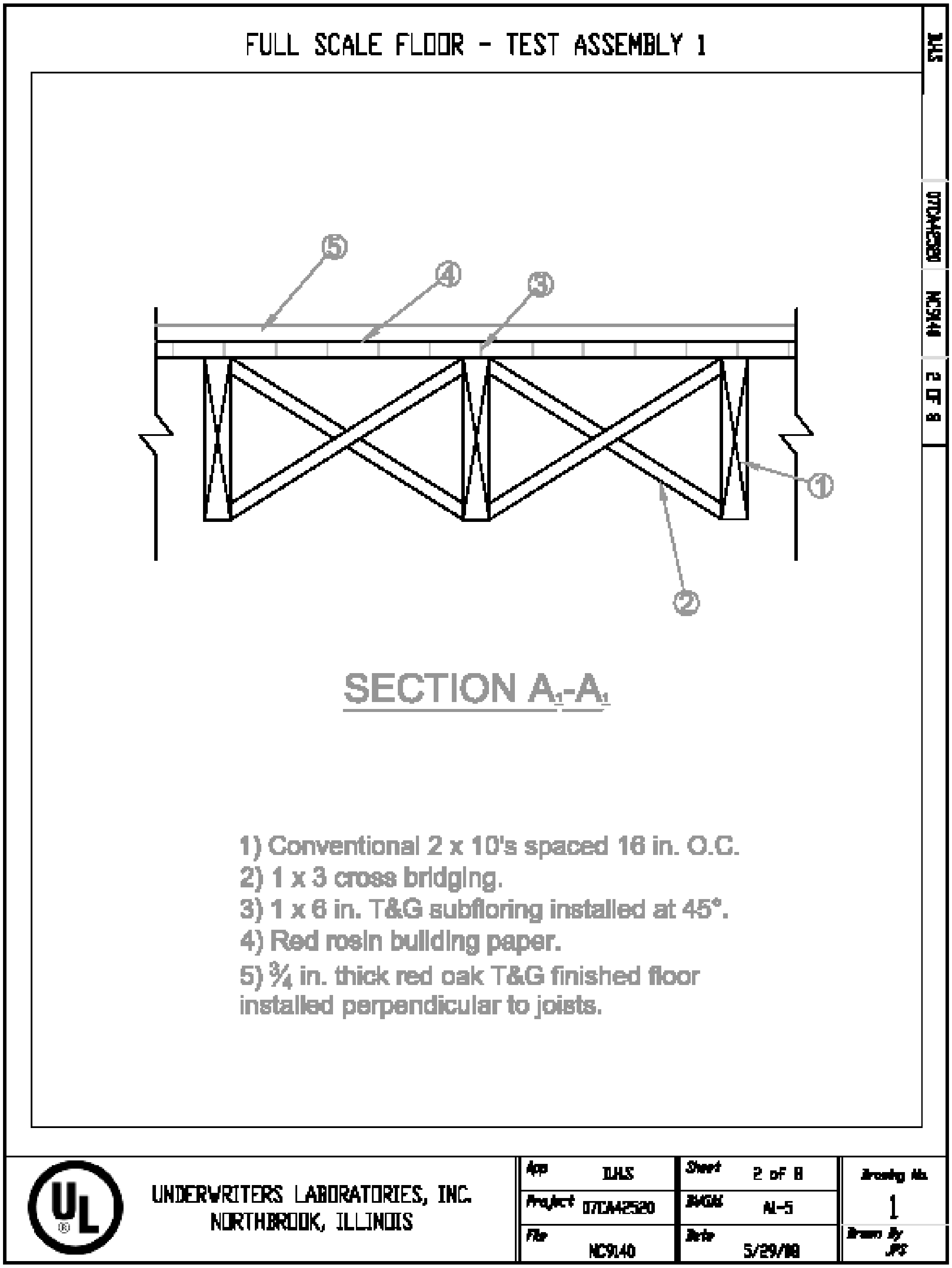


Figure A.1.2 – Construction Layout Section A_1-A_1.

Assembly No. 1

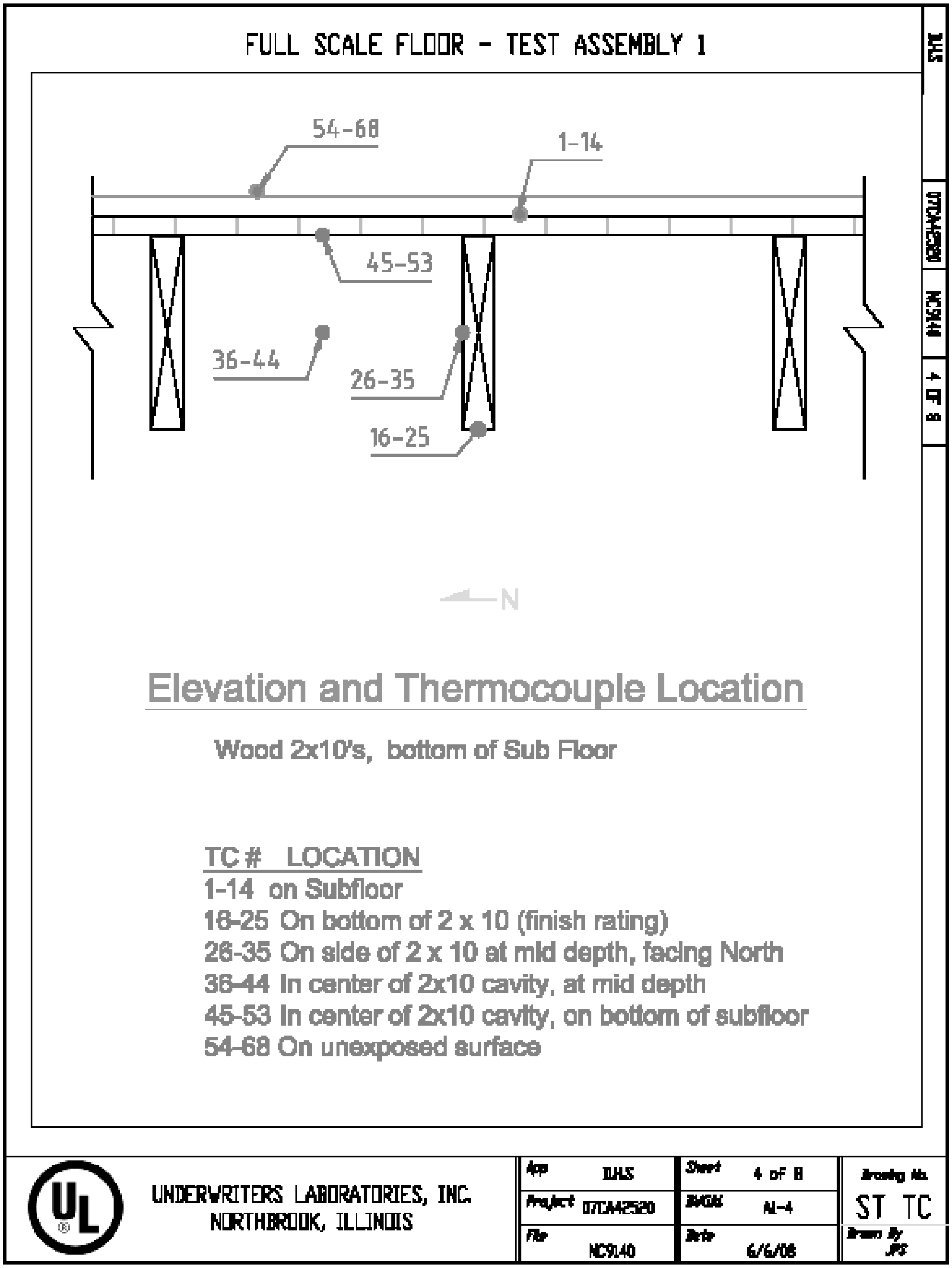


Figure A.1.3 – Thermocouple Locations - Elevation.

Assembly No. 1

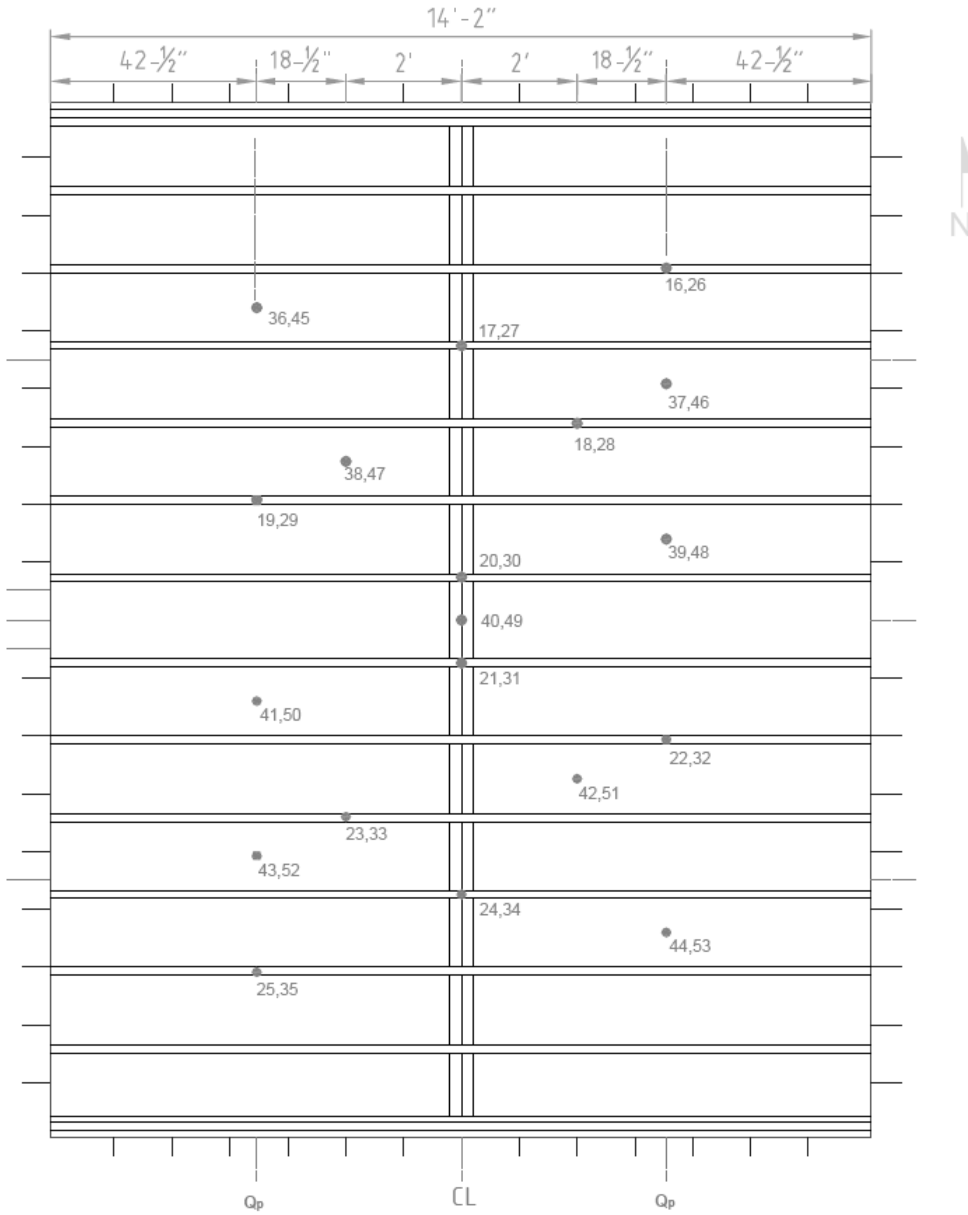


Figure A.1.4 – Thermocouple Locations on Wood Members.

Assembly No. 1

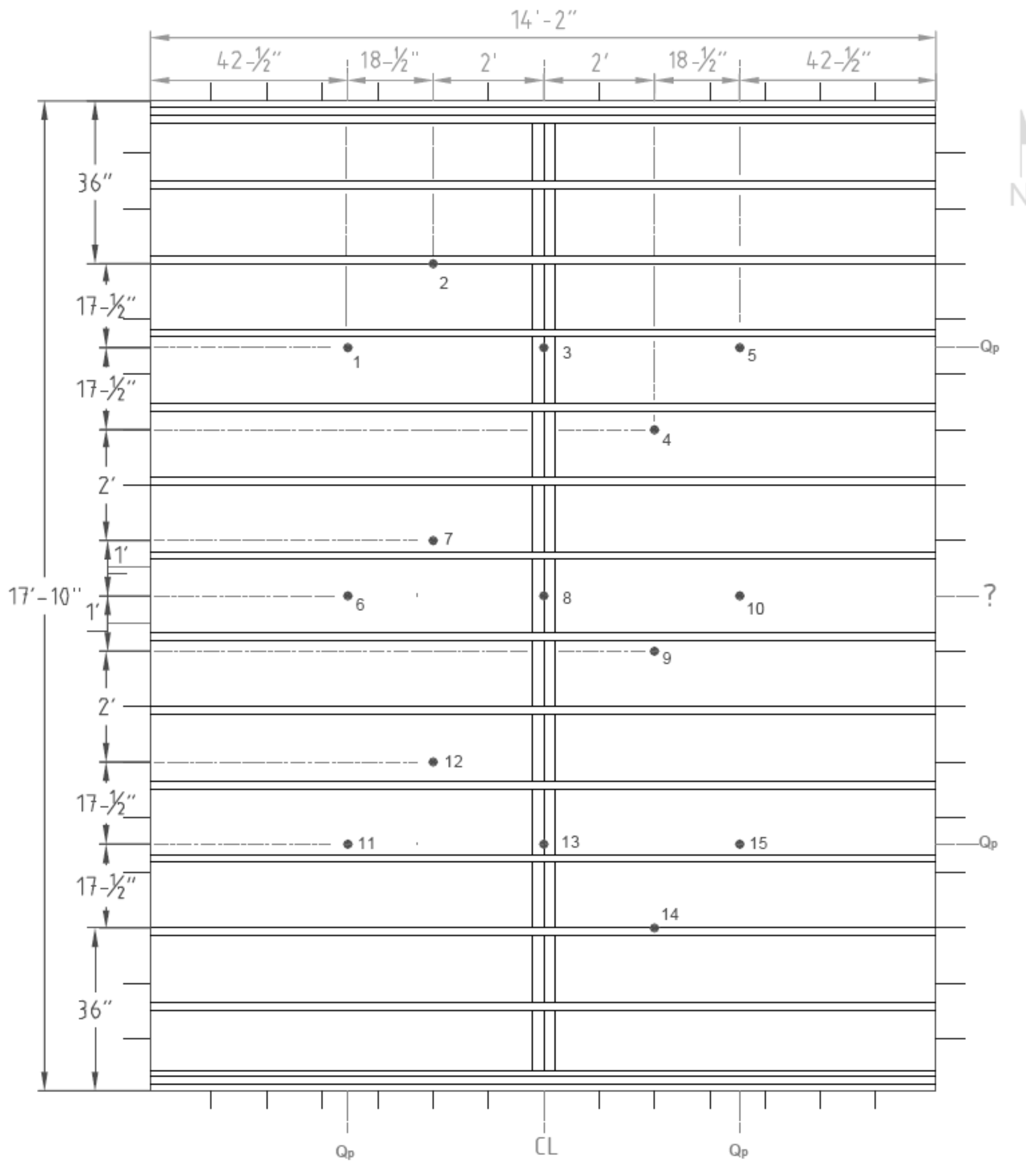


Figure A.1.5 – Thermocouple Locations on Subfloor.

Assembly No. 1

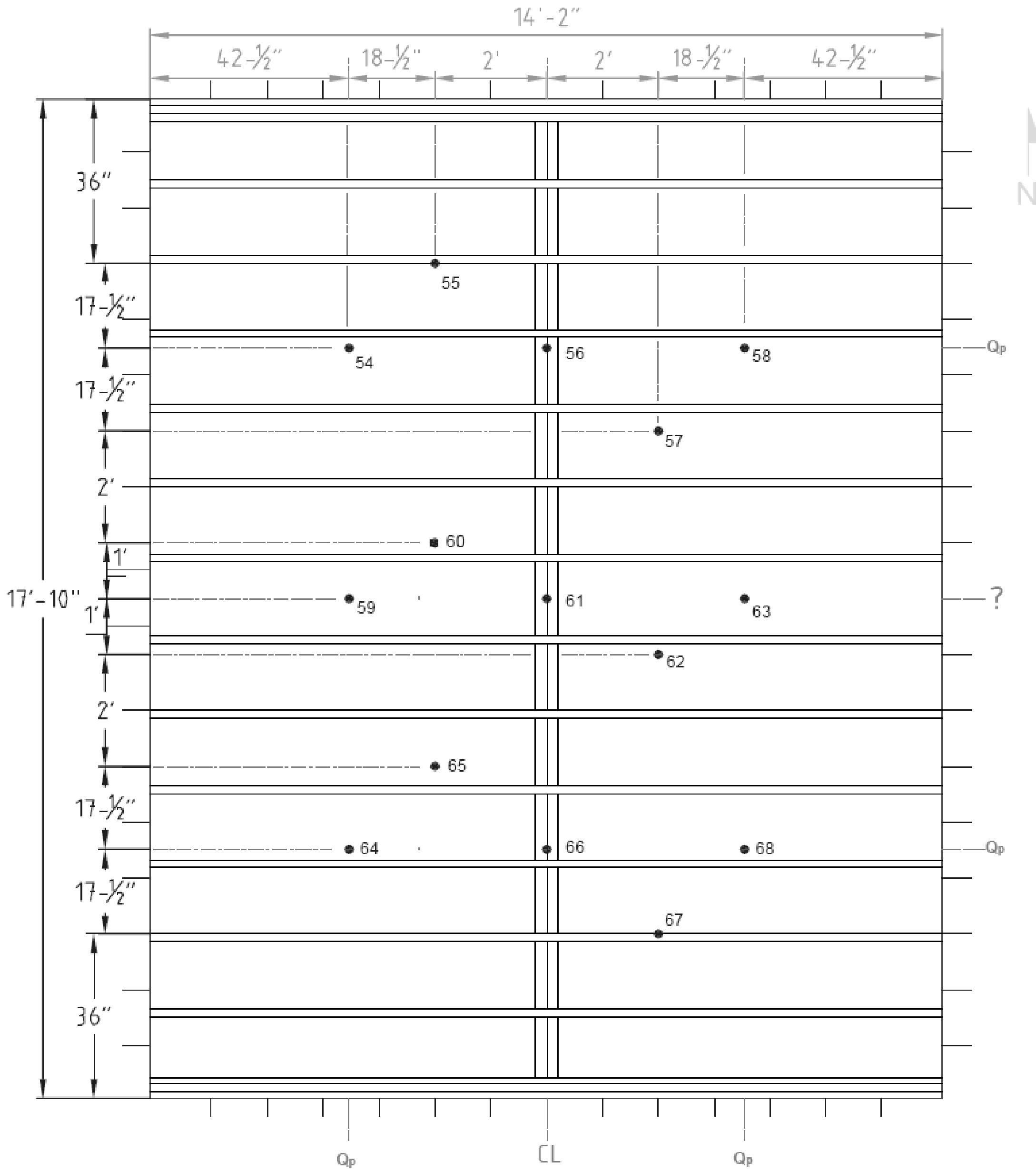


Figure A.1.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 1

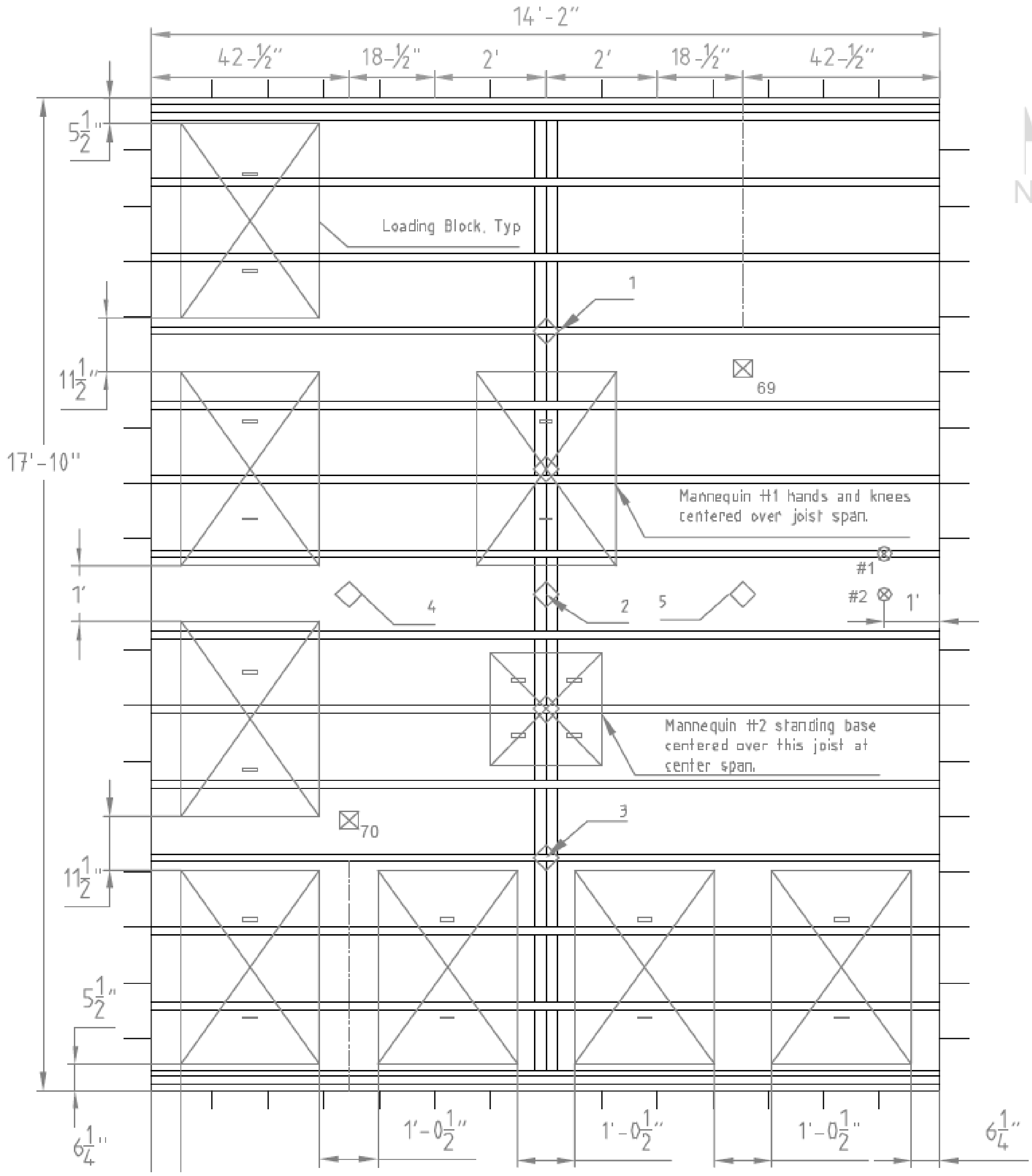


Figure A.1.7 – Loading and Instrumentation Layout (See Figure A.1.8).

Assembly No. 1

Deflection Tranducers: ◇

1 - Along E-W Centerline, North Quarter-point.
2 - Along E-W Centerline, Center-point.
3 - Along E-W Centerline, South Quarter-point.
4 - Along N-S Centerline, East Quarter-point.
5 - Along N-S Centerline, West Quarter-point.

Accelerometers: ⊗

1- Over Joist, 12 in. from East edge of assembly.
2- Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 - Mannequin No. 1 (Hands & Knees)
2 - Mannequin No. 2 (Standing)

Video Camera Recordings: (Not Shown)

Channel 1409 - floor level view from northeast corner
Channel 1411 - IR camera from curing cell roof east center
Channel 1412 - furnace camera from northwest corner
Channel 1416 - overhead from east center of assembly
Channel 1413 - overhead from south west half of assembly
Channel 1415 - overhead from south east half of assembly
Channel 1502 - overhead from west north half of assembly
Channel 1503 - overhead from west south half of assembly

Figure A.1.8 – Loading and Instrumentation Key

Assembly No. 2

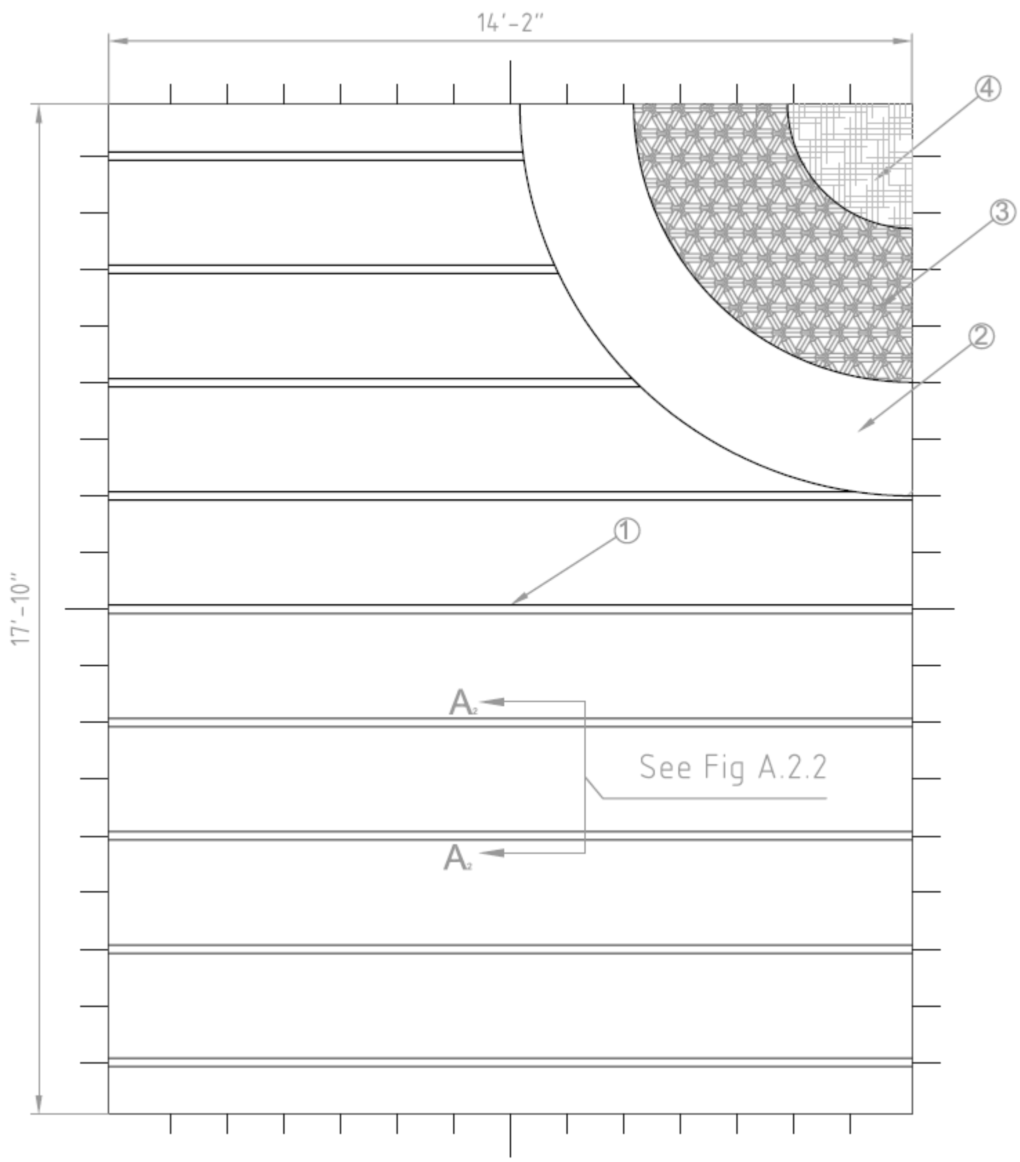


Figure A.2.1 – Construction Layout

Assembly No. 2

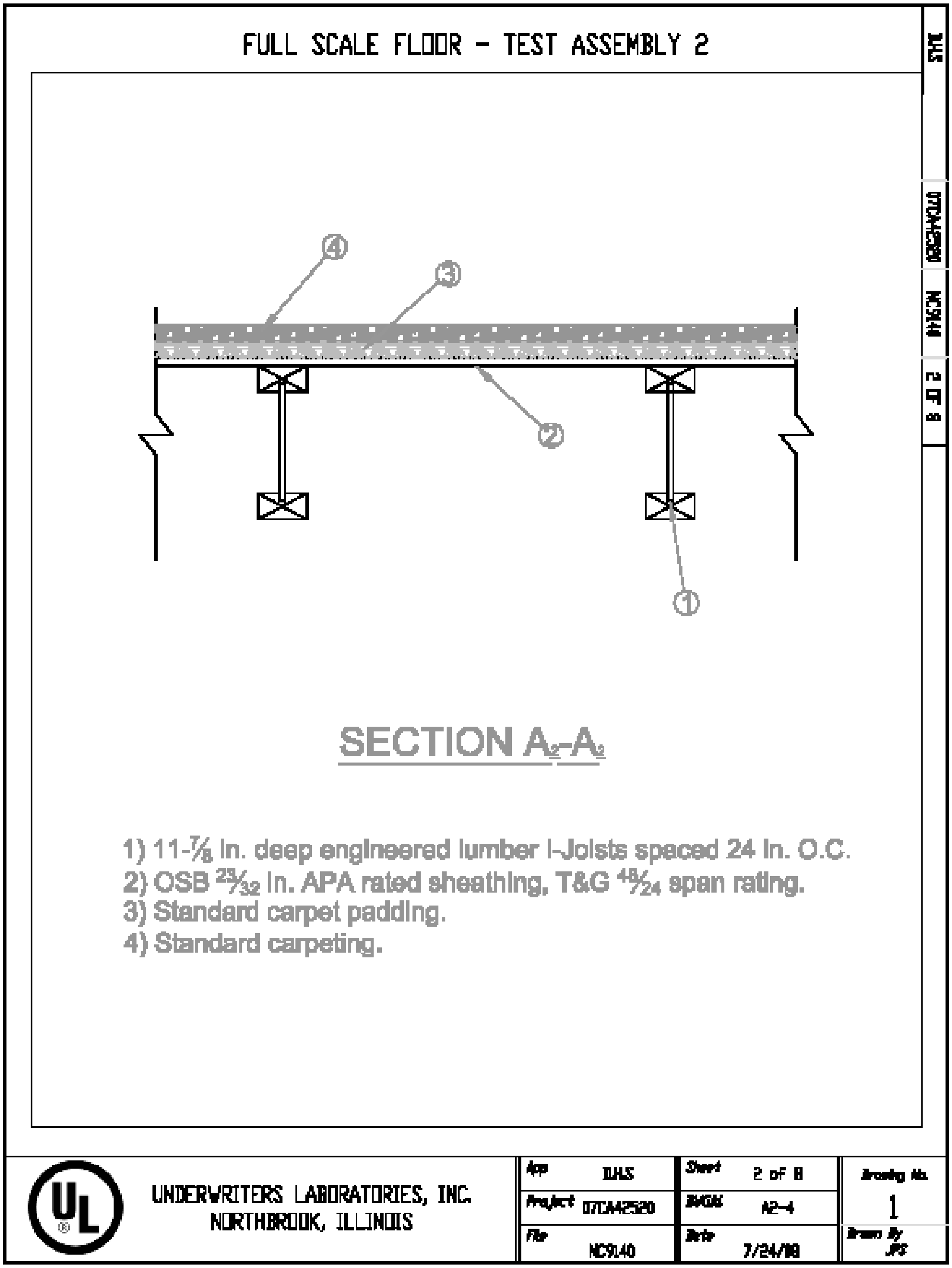


Figure A.2.2 – Construction Layout Section A_2-A_2.

Assembly No. 2

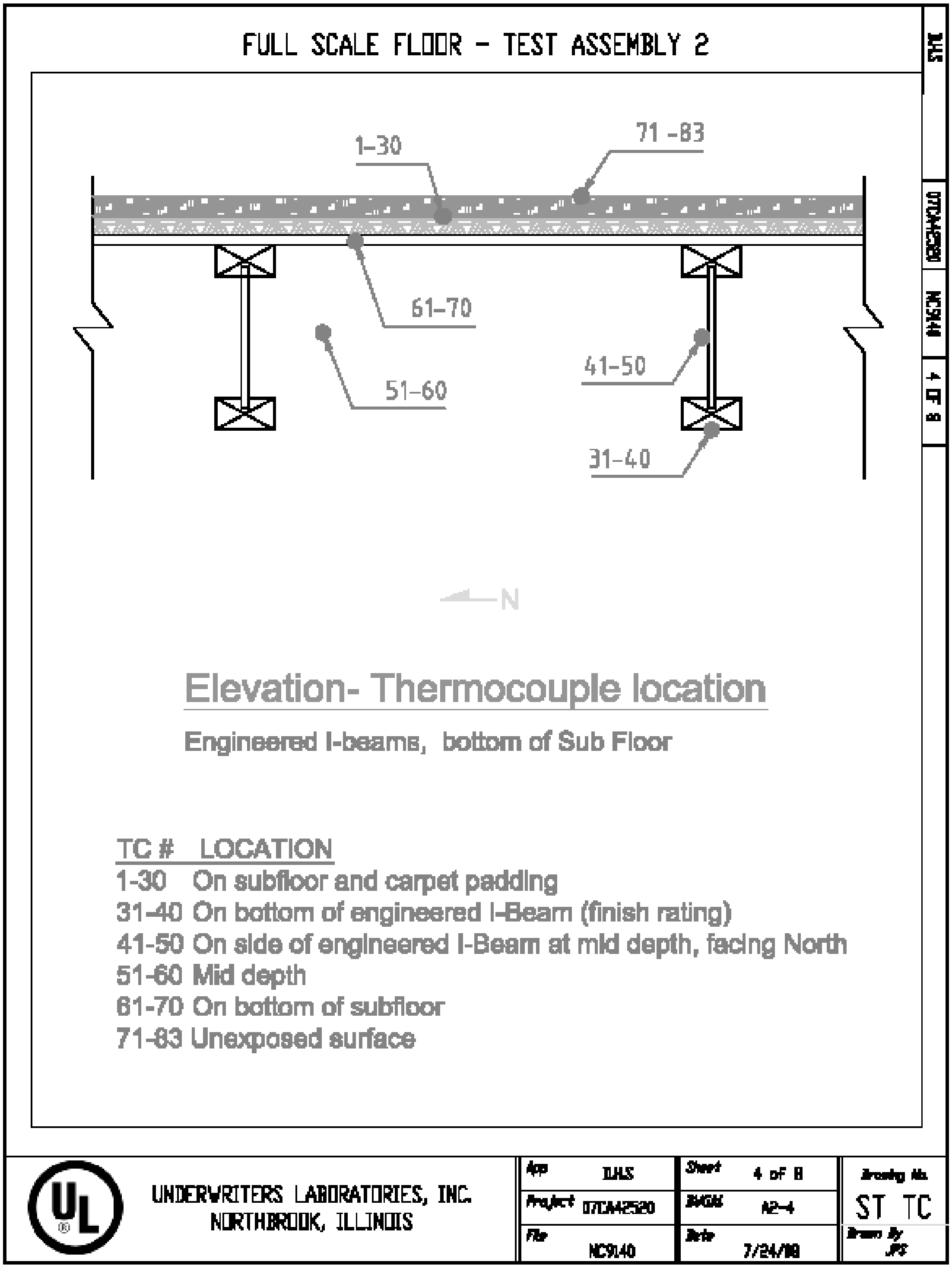


Figure A.2.3 – Thermocouple Locations - Elevation.

Assembly No. 2

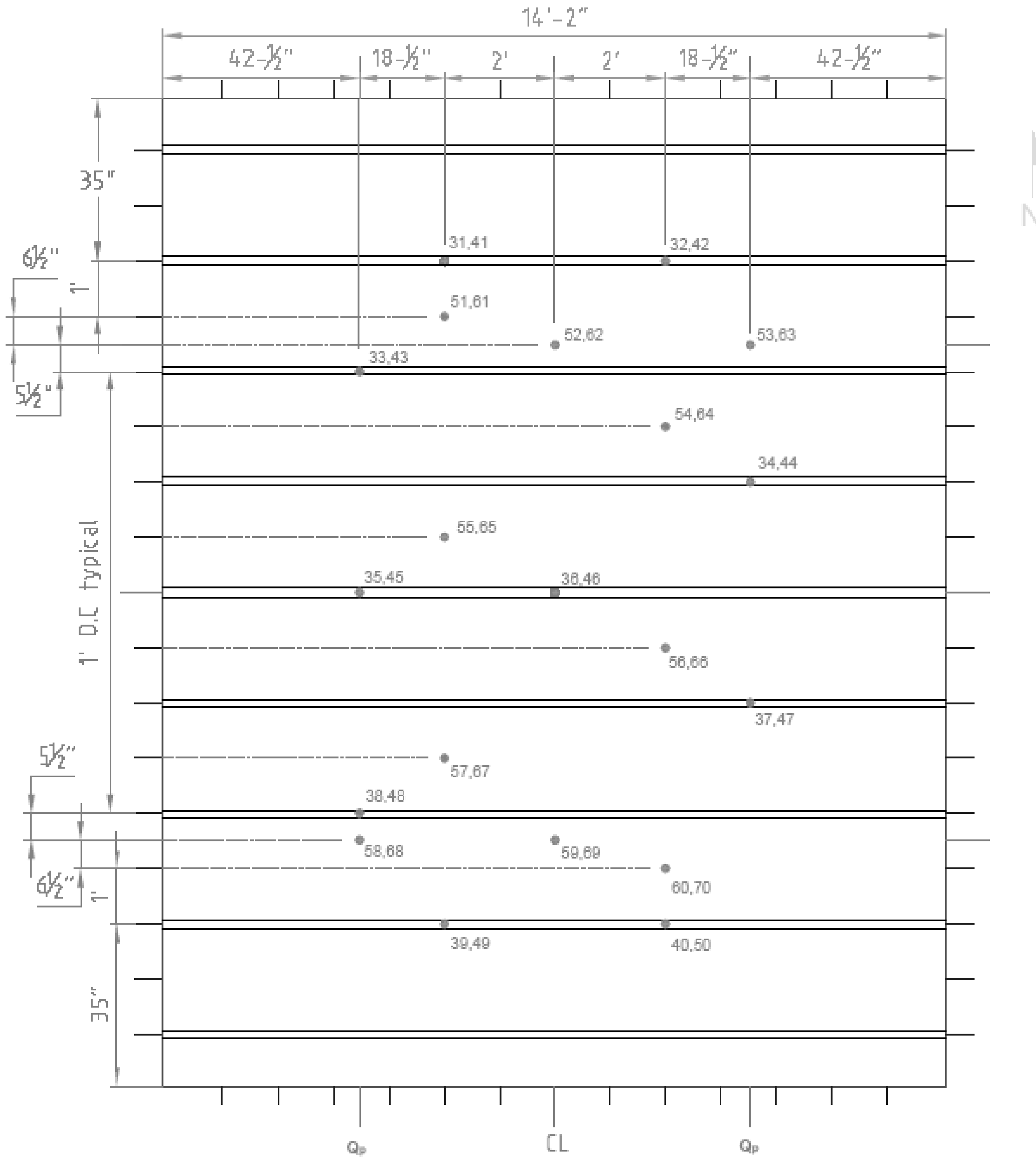


Figure A.2.4 – Thermocouple Locations on Wood Members.

Assembly No. 2

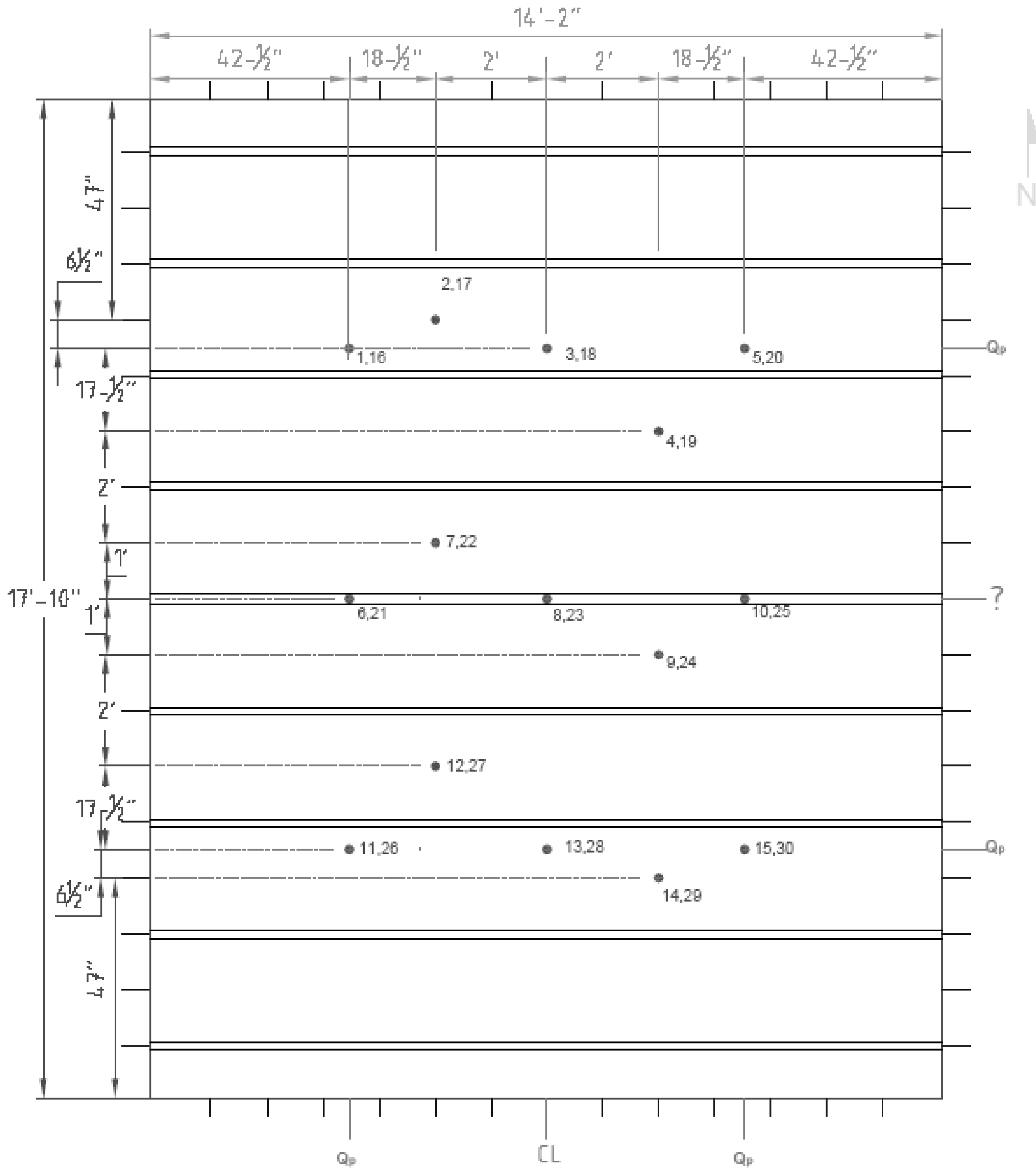


Figure A.2.5 – Thermocouple Locations on Subfloor and Carpet Padding.

Assembly No. 2

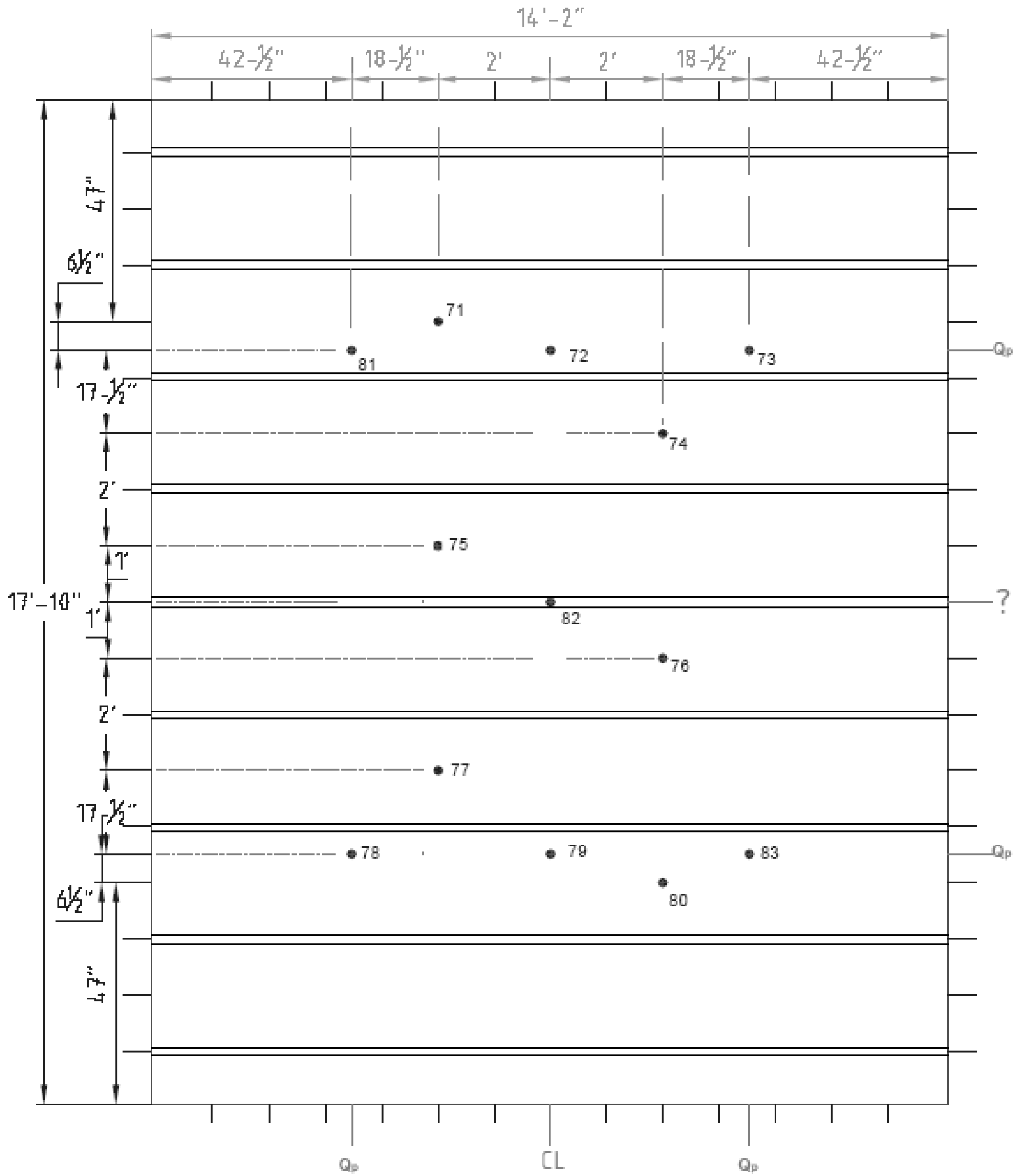


Figure A.2.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 2

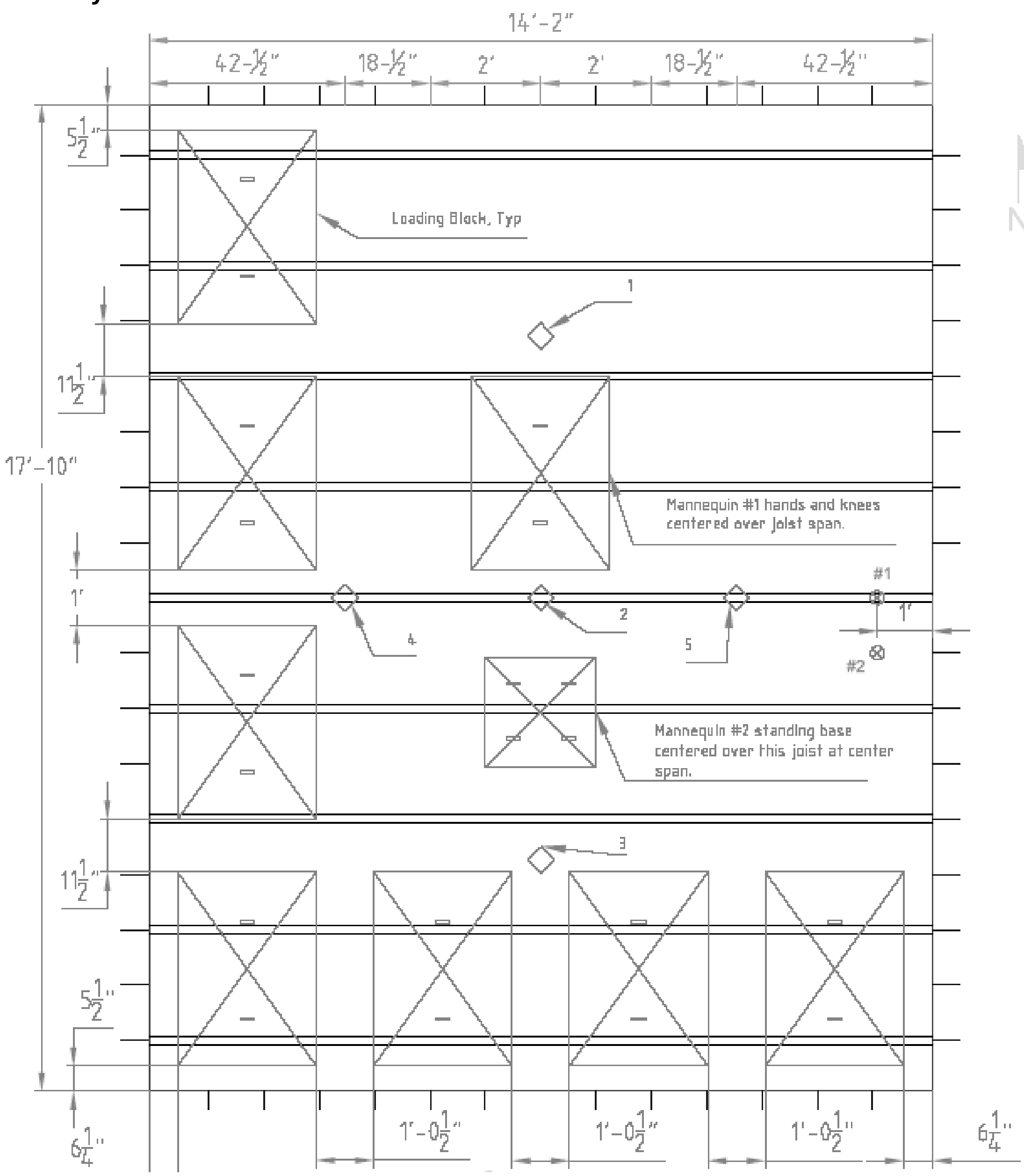


Figure A.2.7 – Loading and Instrumentation Layout (See Figure A.2.8).

Assembly No. 2

Deflection Tranducers: ◇

1 – Along E-W Centerline, North Quarter-point.
2 – Along E-W Centerline, Center-point.
3 – Along E-W Centerline, South Quarter-point.
4 – Along N-S Centerline, East Quarter-point.
5 – Along N-S Centerline, West Quarter-point.

Accelerometers: ⊗

1– Over Joist, 12 in. from East edge of assembly.
2– Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 – Mannequin No. 1 (Hands & Knees)
2 – Mannequin No. 2 (Standing)

Video Camera Recordings:(Not Shown)

Channel 1409 – floor level view from northeast corner
Channel 1411 – IR camera from curing cell roof east center
Channel 1412 – furnace camera from northwest corner
Channel 1416 – overhead from east center of assembly
Channel 1413 – overhead from south west half of assembly
Channel 1415 – overhead from south east half of assembly
Channel 1502 – overhead from west north half of assembly
Channel 1503 – overhead from west south half of assembly

Figure A.2.8 – Loading and Instrumentation Key

Assembly No. 3

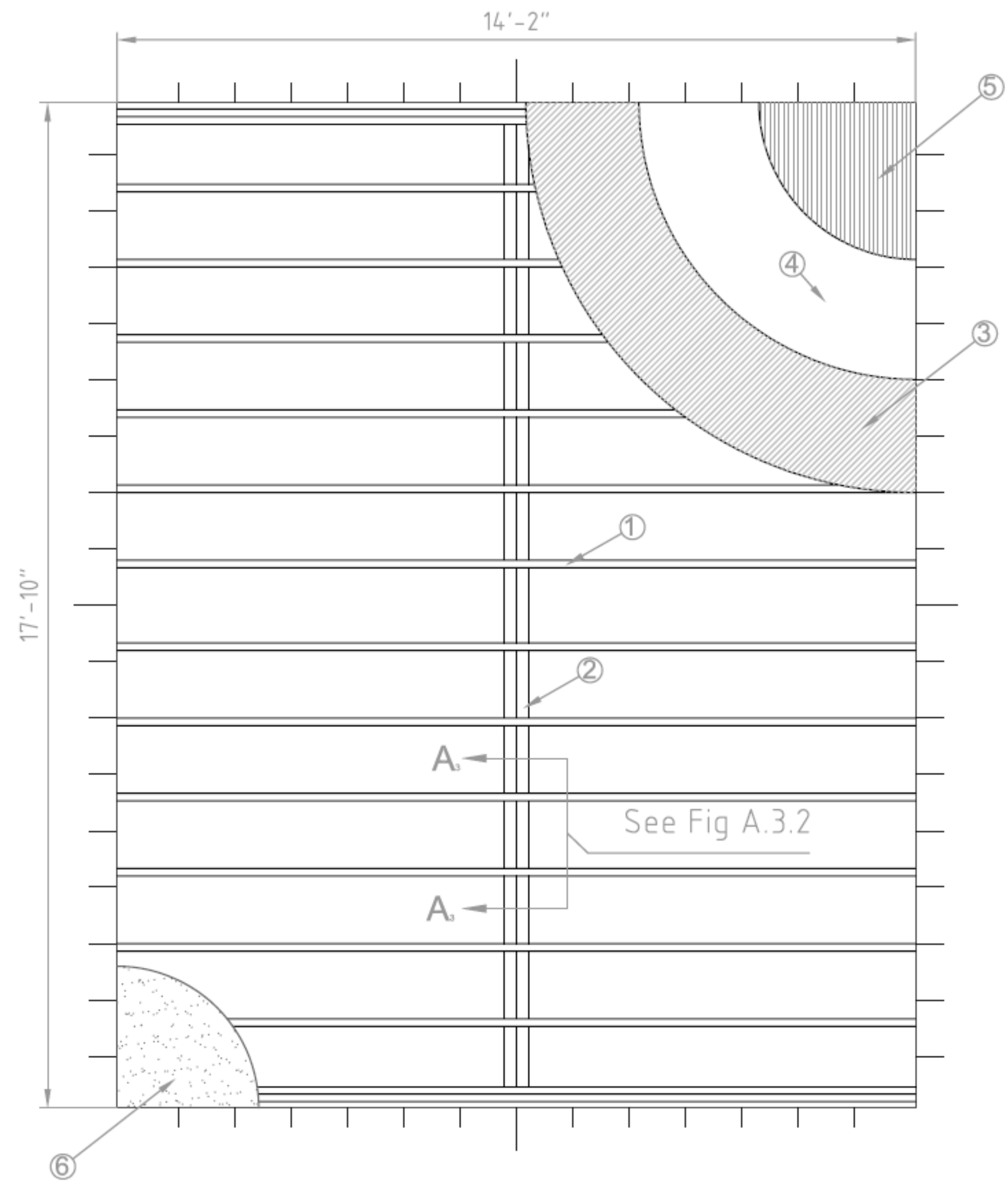


Figure A.3.1 – Construction Layout.

Assembly No. 3

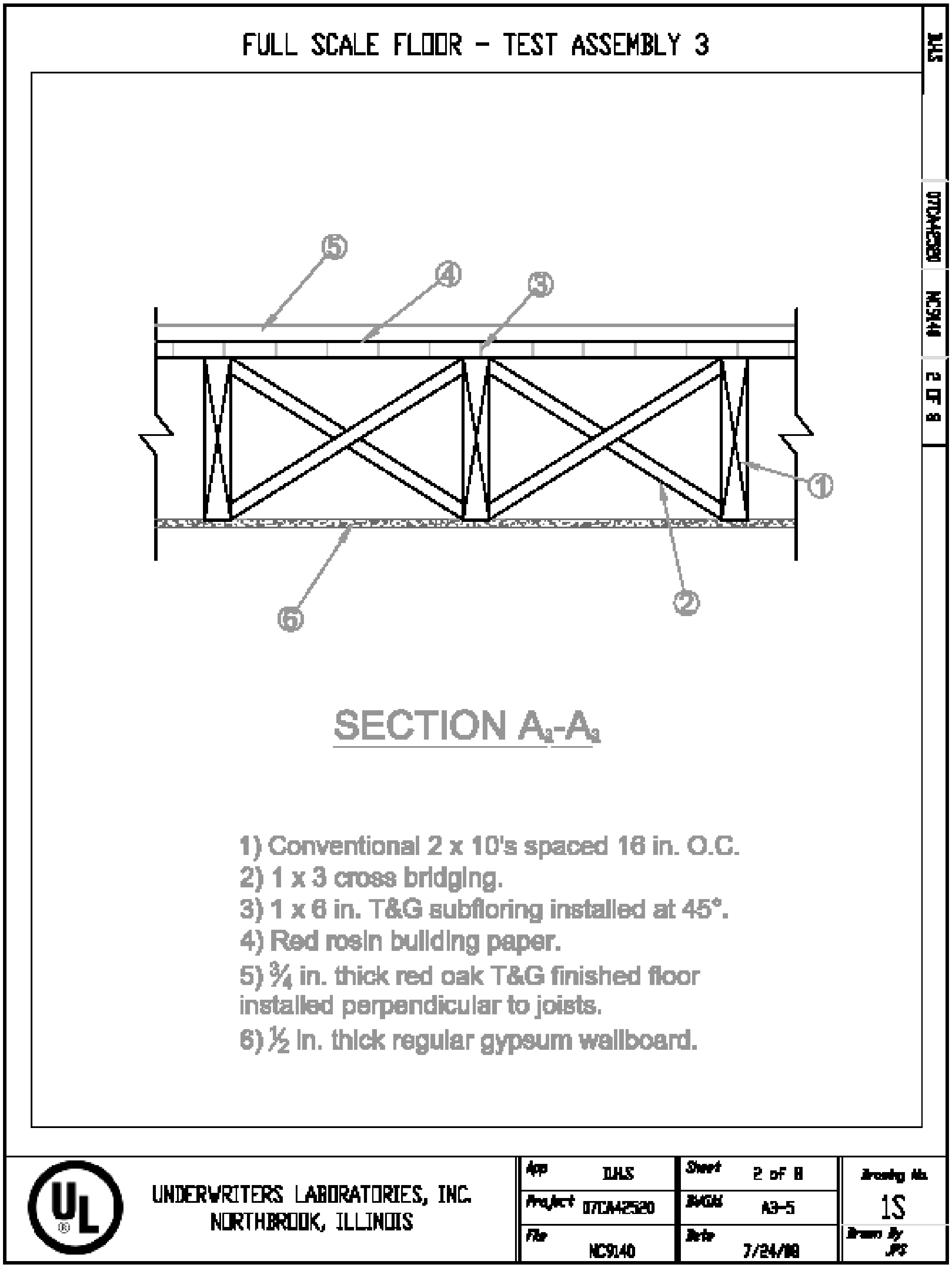


Figure A.3.2 – Construction Layout Section A_3-A_3.

Assembly No. 3

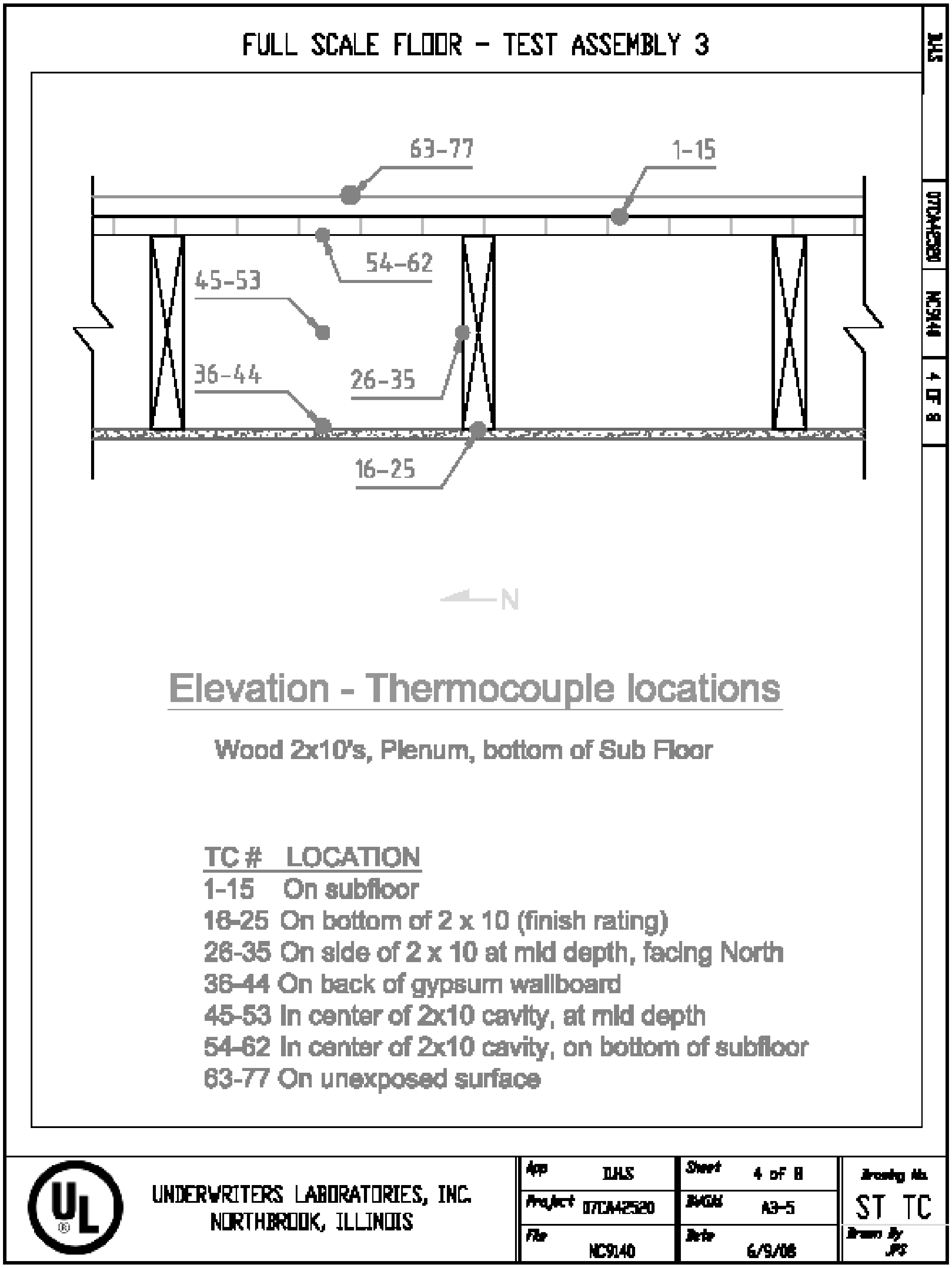


Figure A.3.3 – Thermocouple Locations - Elevation.

Assembly No. 3

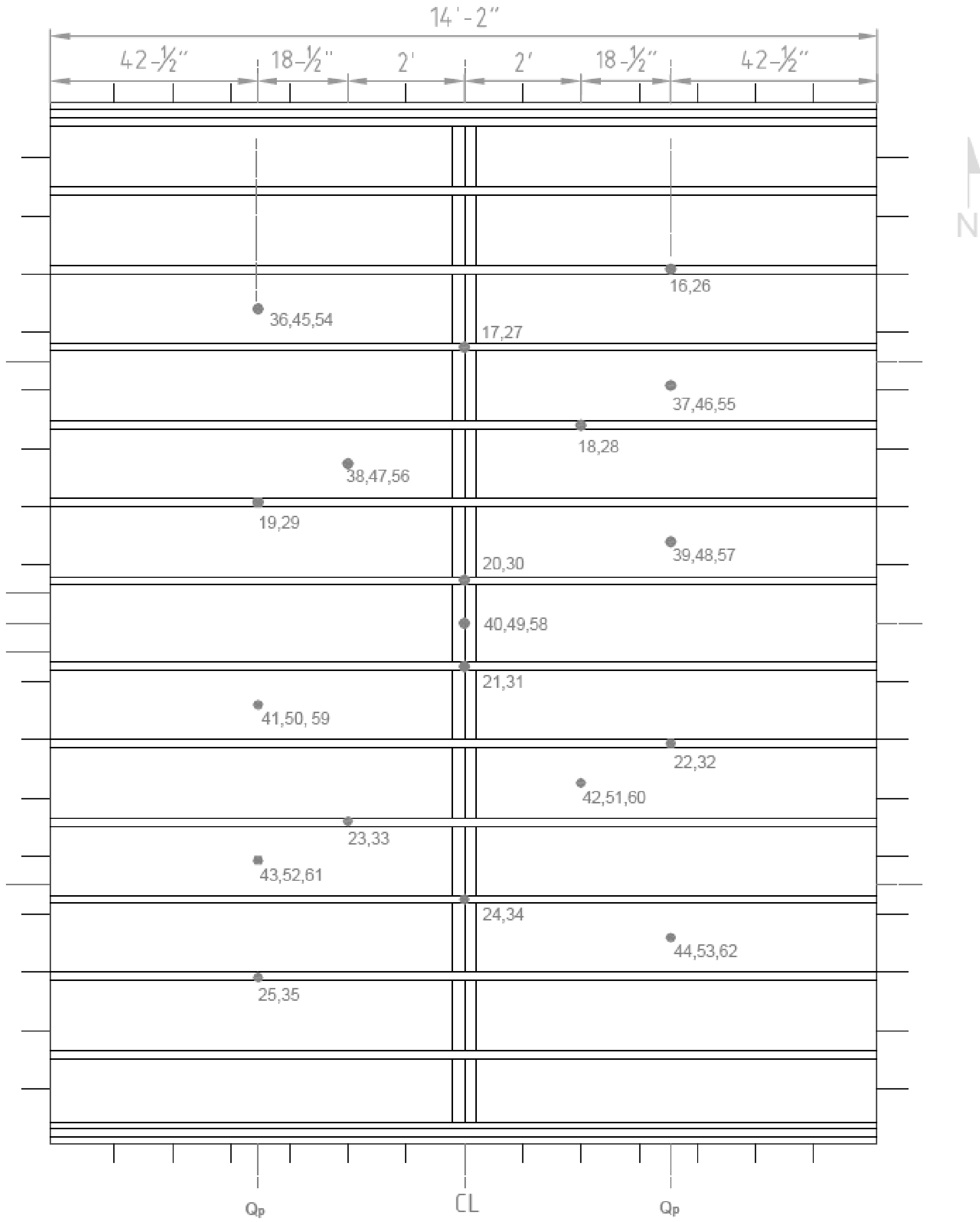


Figure A.3.4 – Thermocouple Locations on Wood Member.

Assembly No. 3

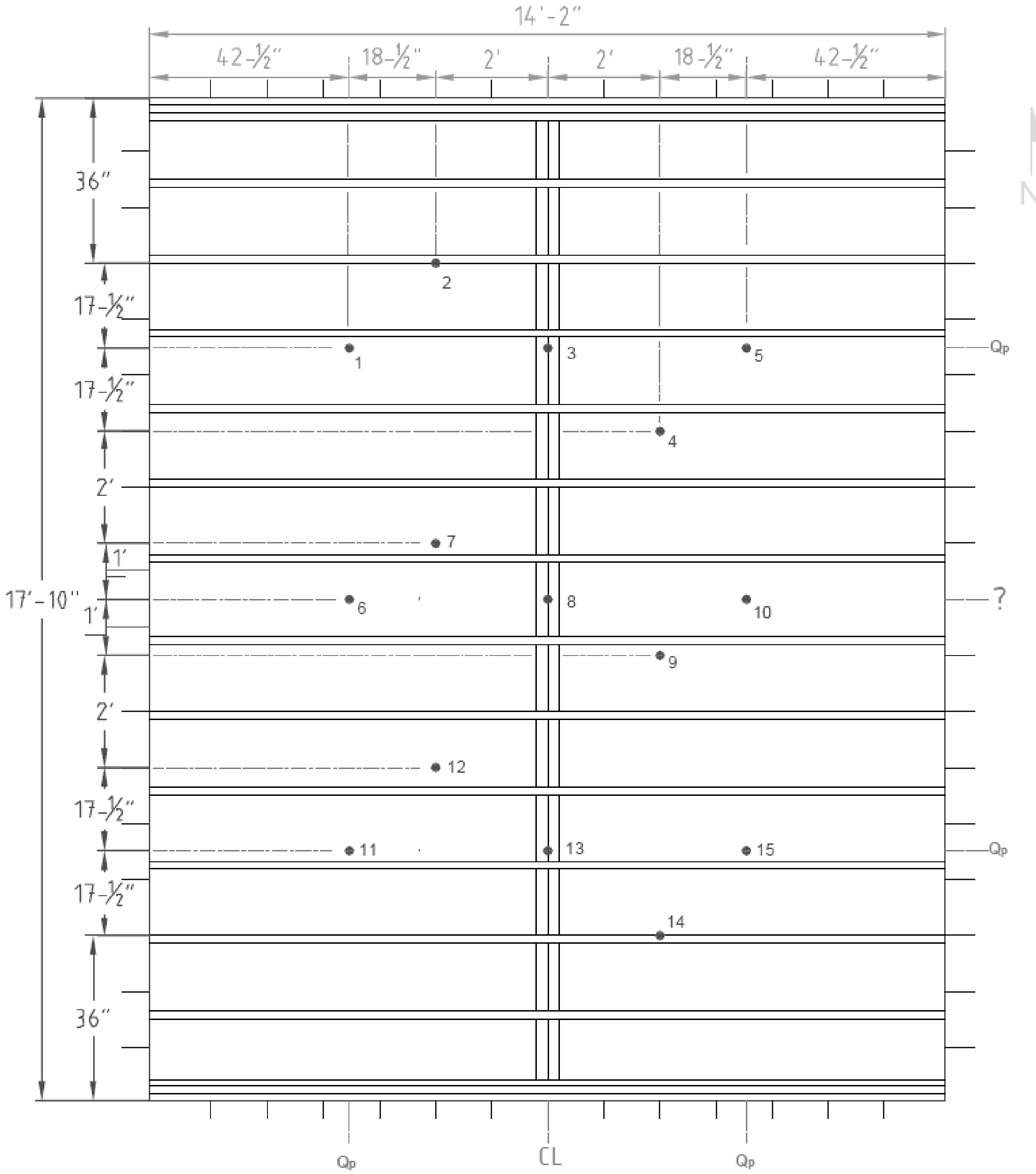


Figure A.3.5 – Thermocouple Locations on Subfloor.

Assembly No. 3

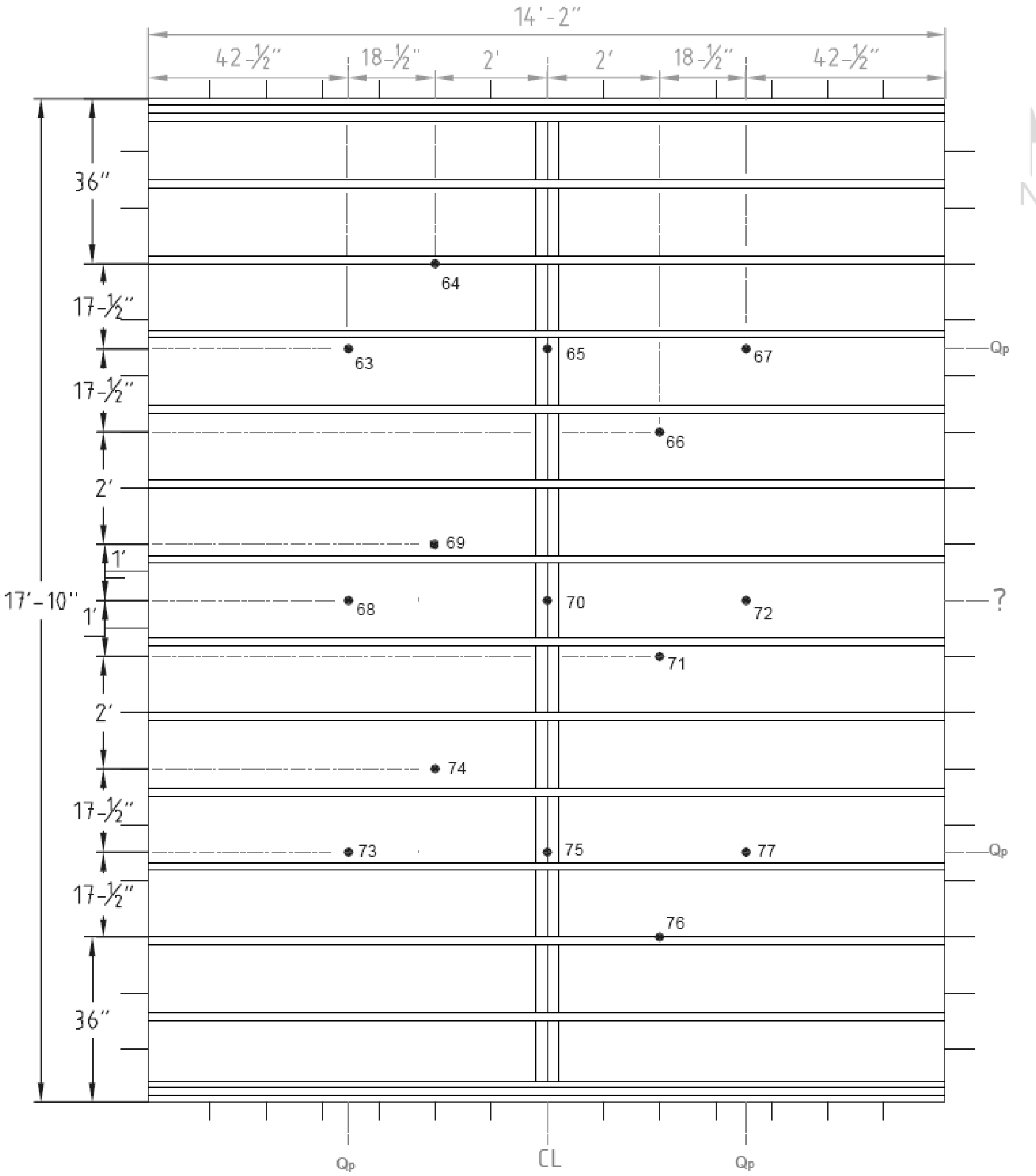


Figure A.3.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 3

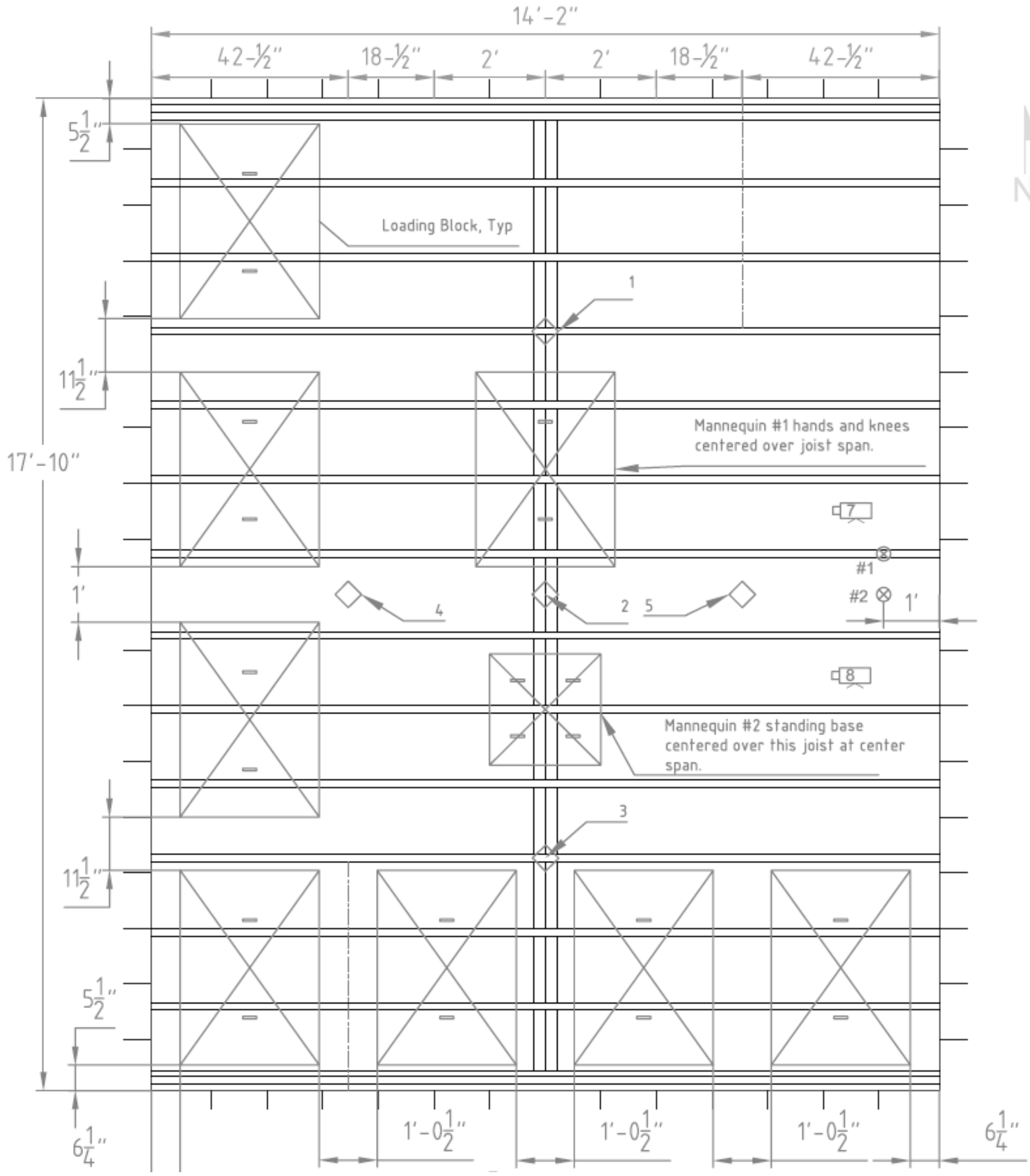


Figure A.3.7 – Loading and Instrumentation Layout (See Figure A.3.8).

Assembly No. 3

Deflection Transducers: ◇

1 - Along E-W Centerline, North Quarter-point.
2 - Along E-W Centerline, Center-point.
3 - Along E-W Centerline, South Quarter-point.
4 - Along N-S Centerline, East Quarter-point.
5 - Along N-S Centerline, West Quarter-point.

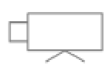
Accelerometers: ⊗

1- Over Joist, 12 in. from East edge of assembly.
2- Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 - Mannequin No. 1 (Hands & Knees)
2 - Mannequin No. 2 (Standing)

Video Camera Recordings: (Not Shown)
Channel 1409 - floor level view from northeast corner
Channel 1411 - IR camera from curing cell roof east center
Channel 1412 - furnace camera from northwest corner
Channel 1416 - overhead from east center of assembly
Channel 1413 - overhead from south center of assembly
Channel 1503 - overhead from west center of assembly

Video Camera Recordings: 

Channel 1415 - internal camera east (installed in joist cavity 6 from north facing west - under kneeling mannequin #1.
Channel 1502 - internal camera east (installed in joist cavity 8 from north facing west -under standing mannequin #2.

Furnace Pressure Probes: (Not Shown)
1 - located near plate thermocouple No. 78
2 - located near plate thermocouple No. 79

Oxygen Content : (Not Shown)
located in E exhaust duct.

Figure A.3.8 – Loading and Instrumentation Key

Assembly No. 4

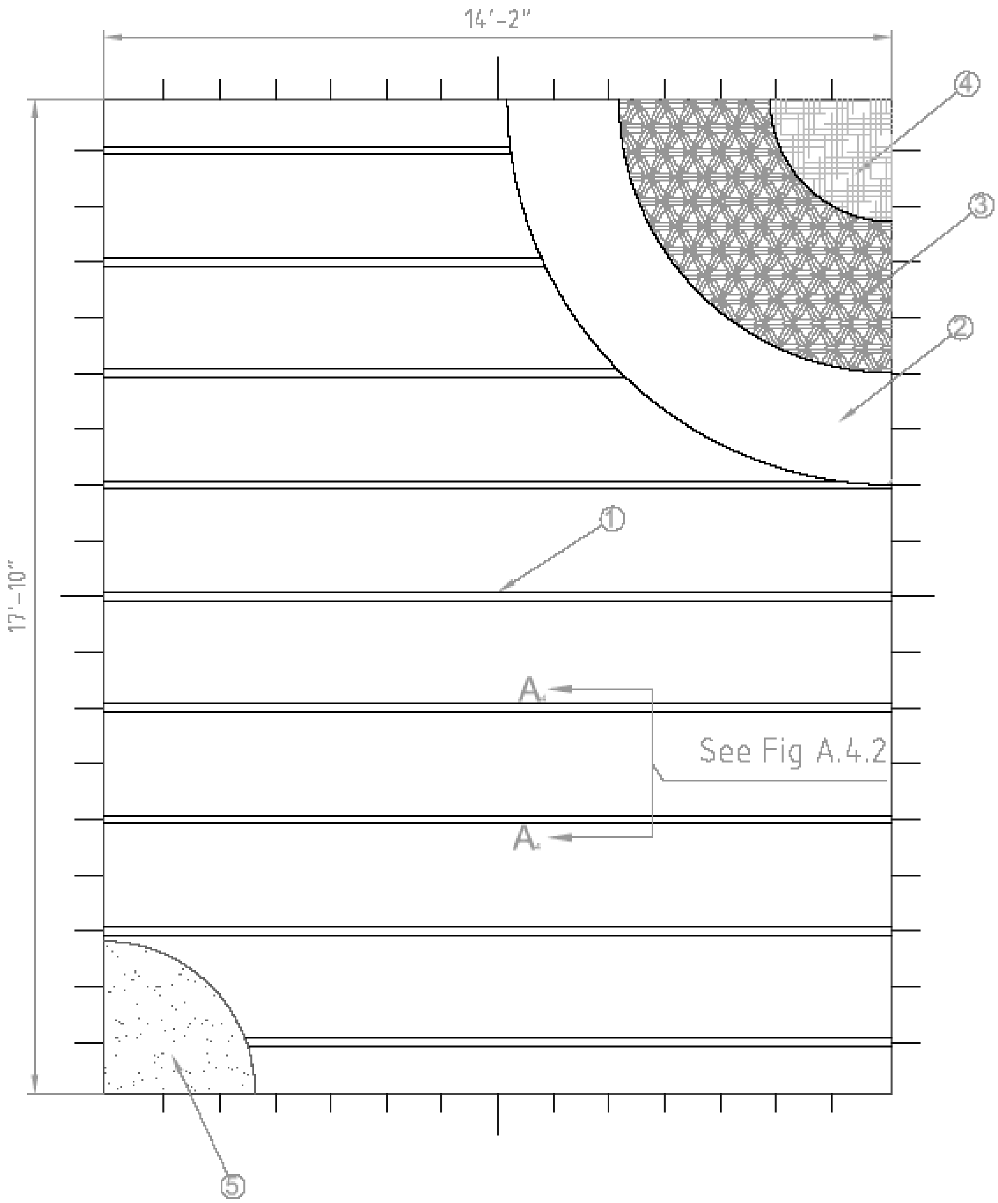


Figure A.4.1 – Construction Layout

Assembly No. 4

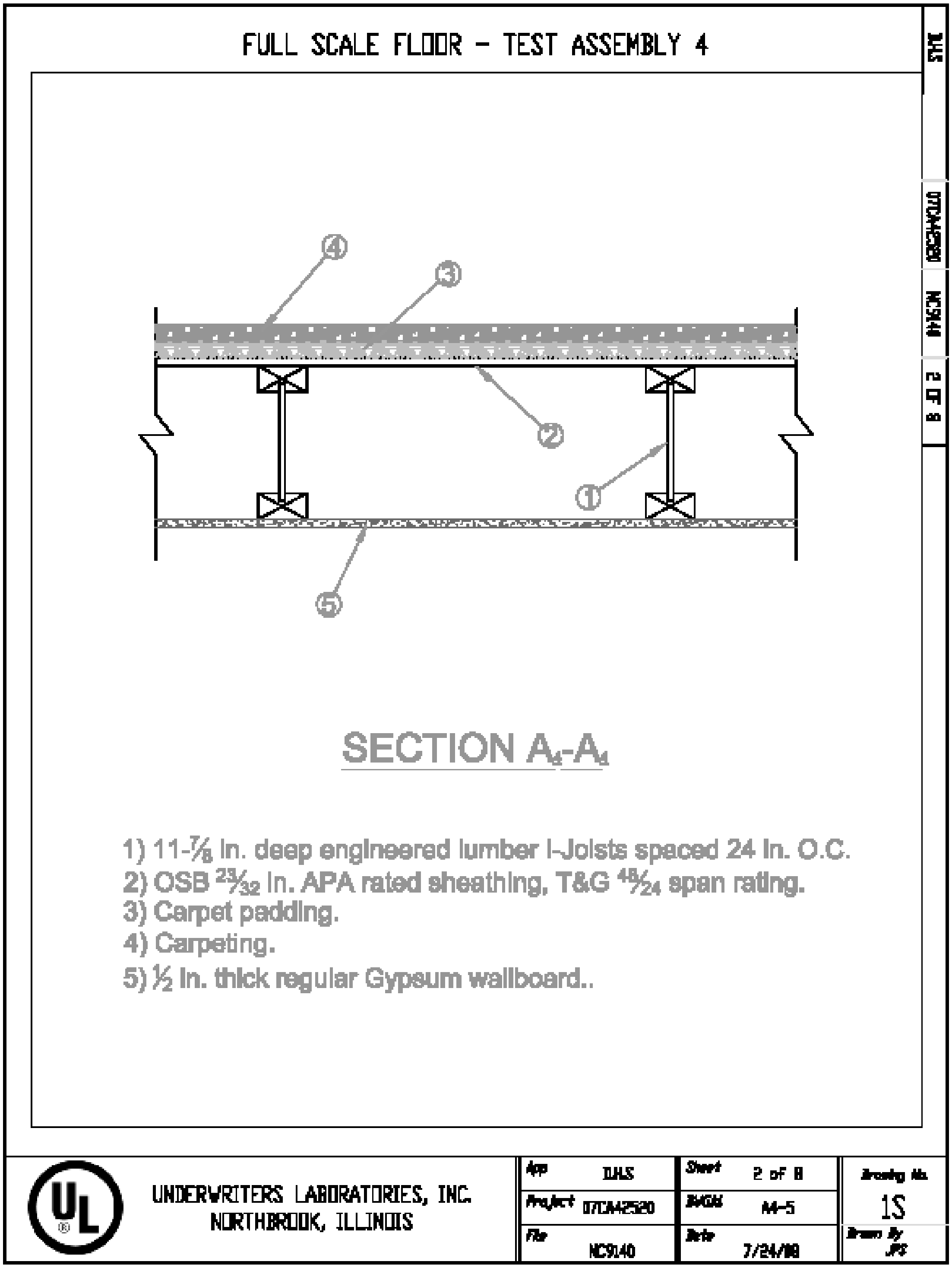


Figure A.4.2 – Construction Layout Section A_4-A_4.

Assembly No. 4

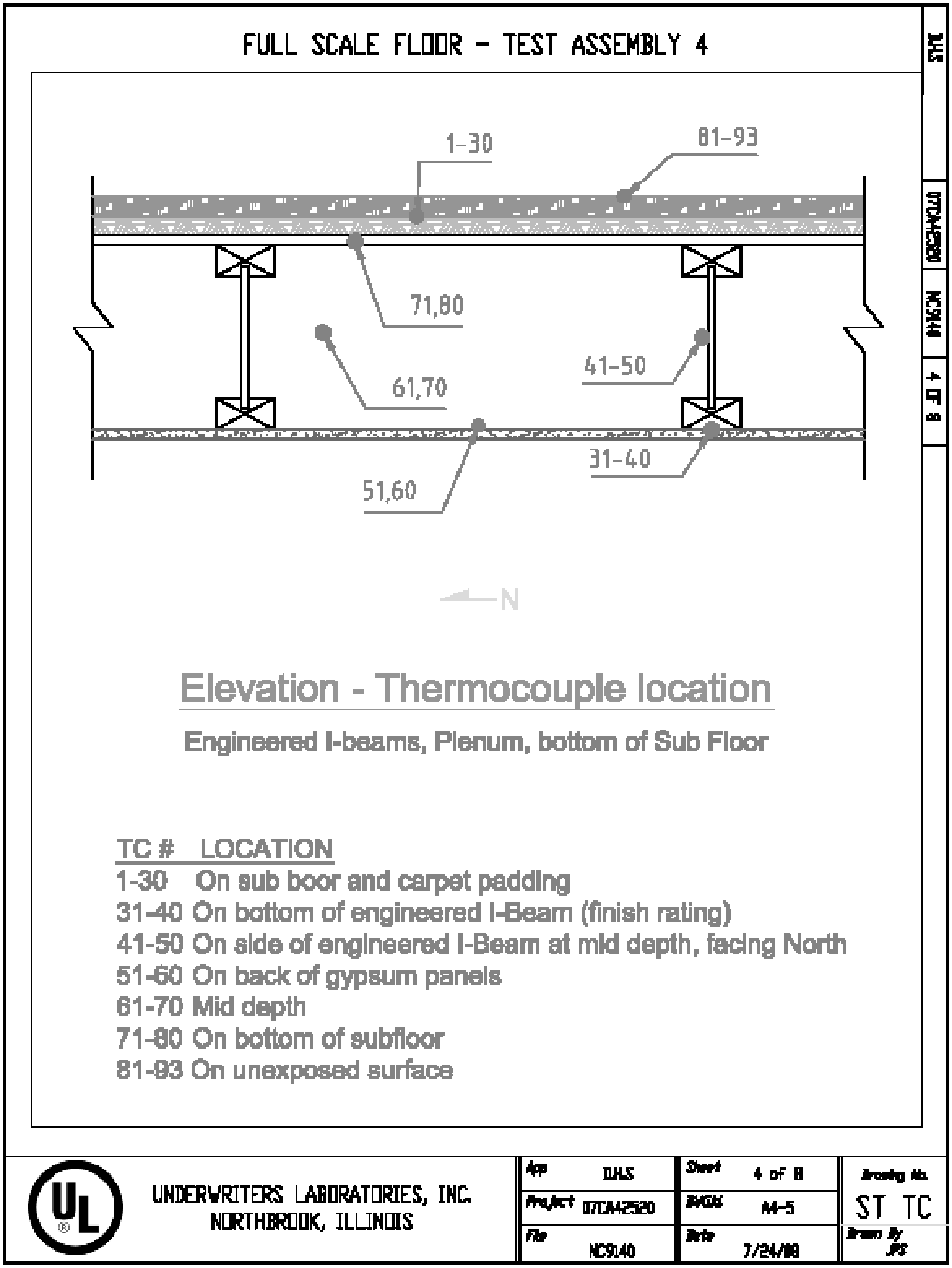


Figure A.4.3 – Thermocouple Locations - Elevation.

Assembly No. 4

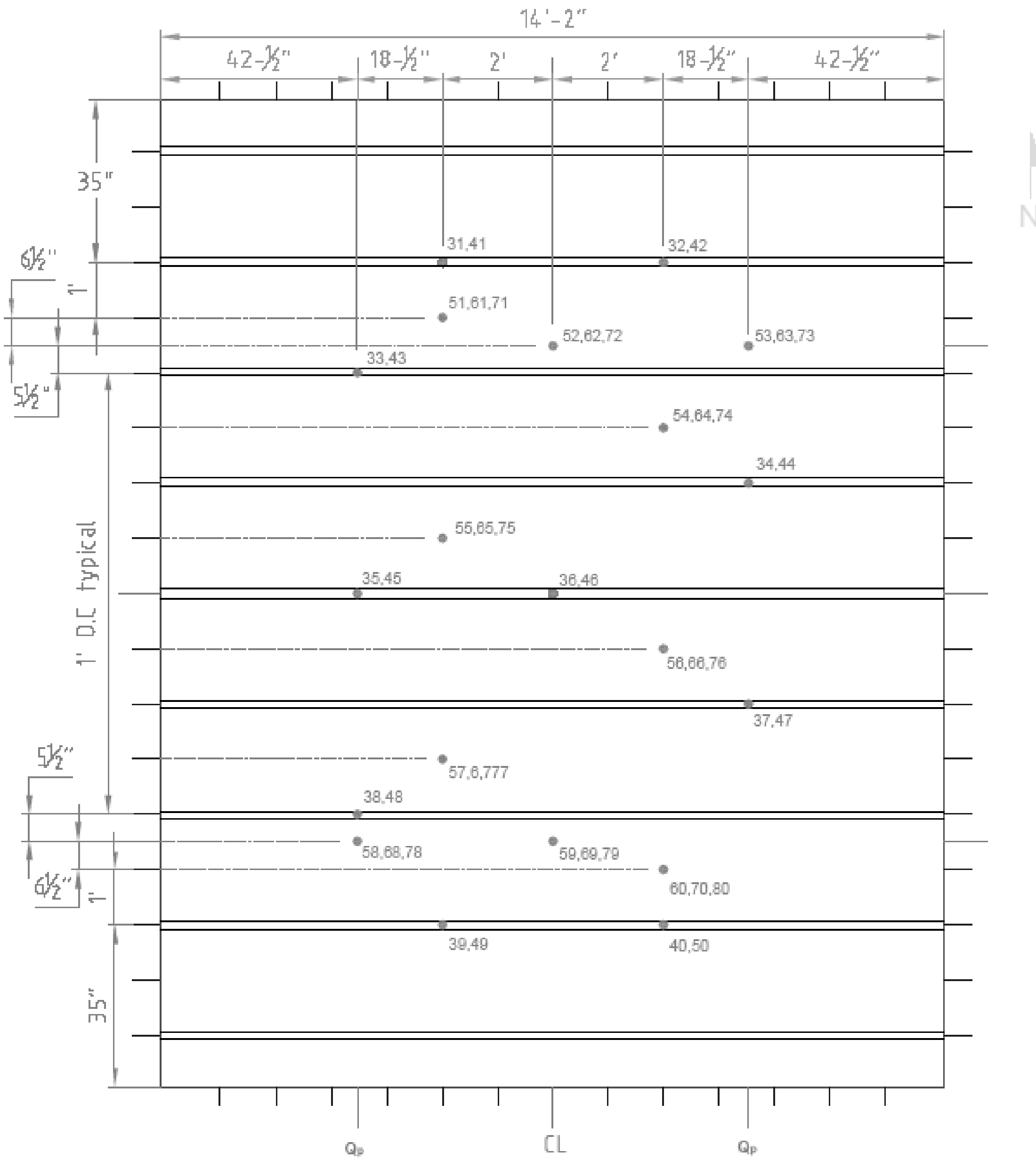


Figure A.4.4 – Thermocouple Locations on Wood Members.

Assembly No. 4

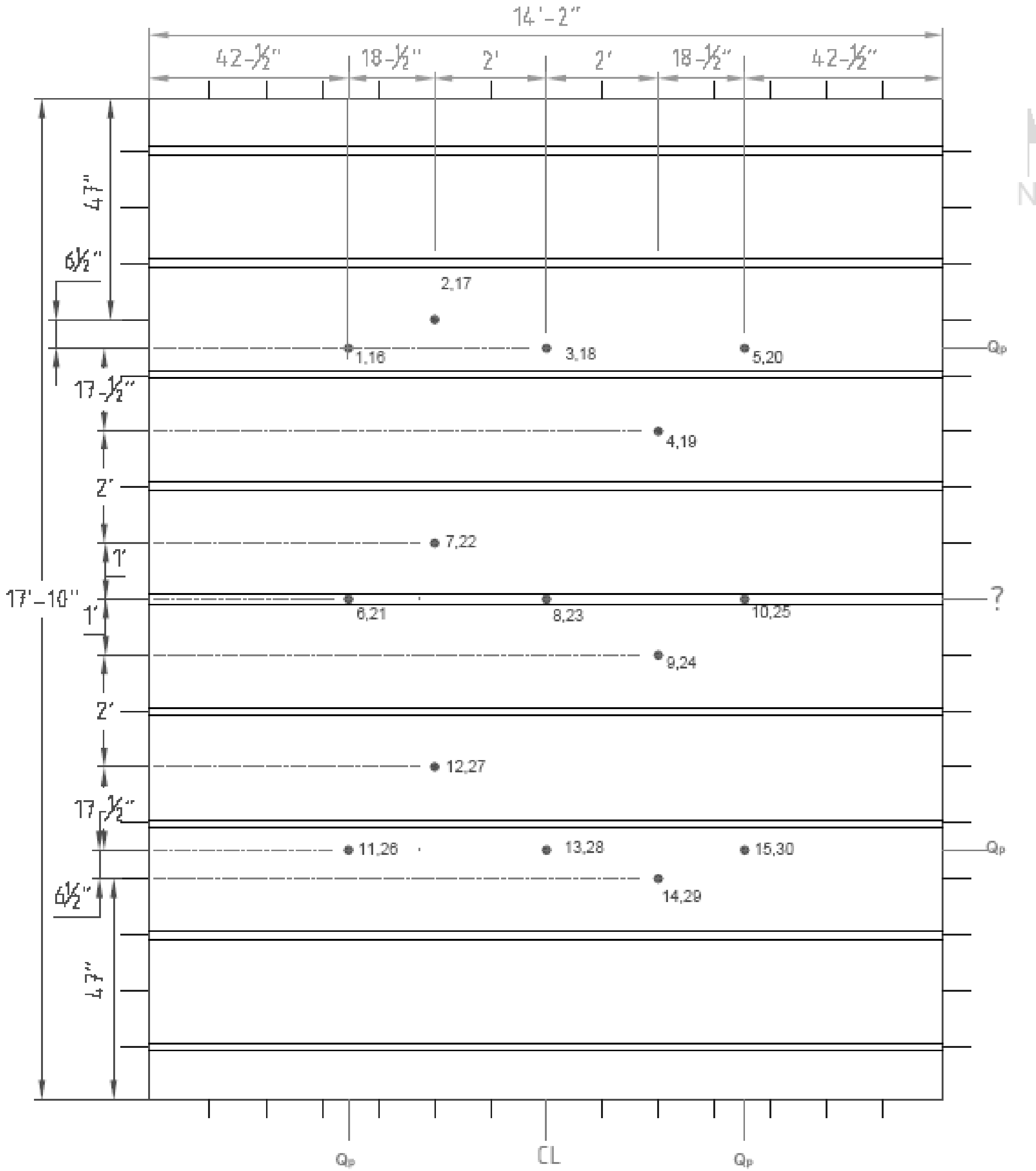


Figure A.4.5 – Thermocouple Locations on Subfloor and Carpet Padding.

Assembly No. 4

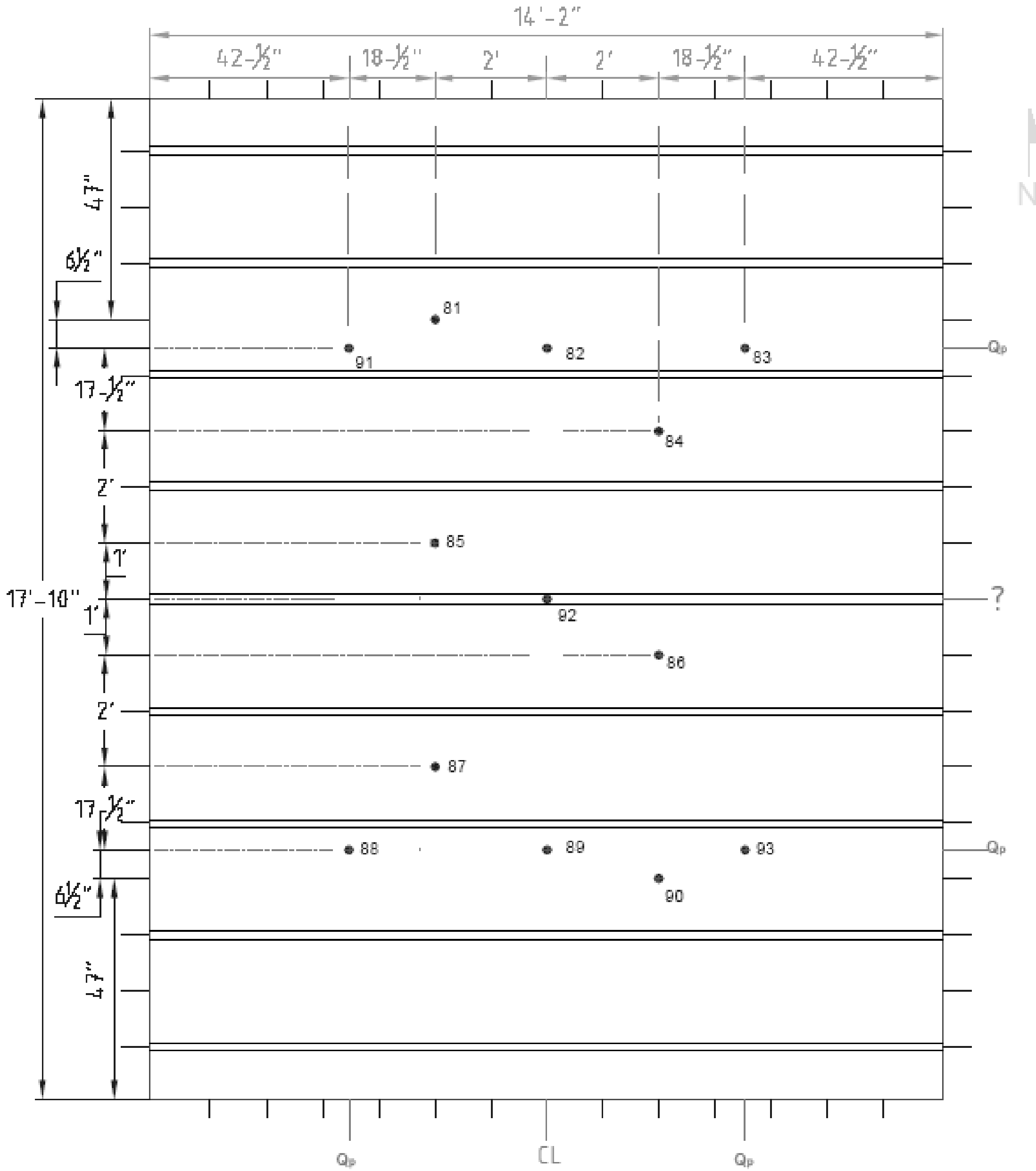


Figure A.4.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 4

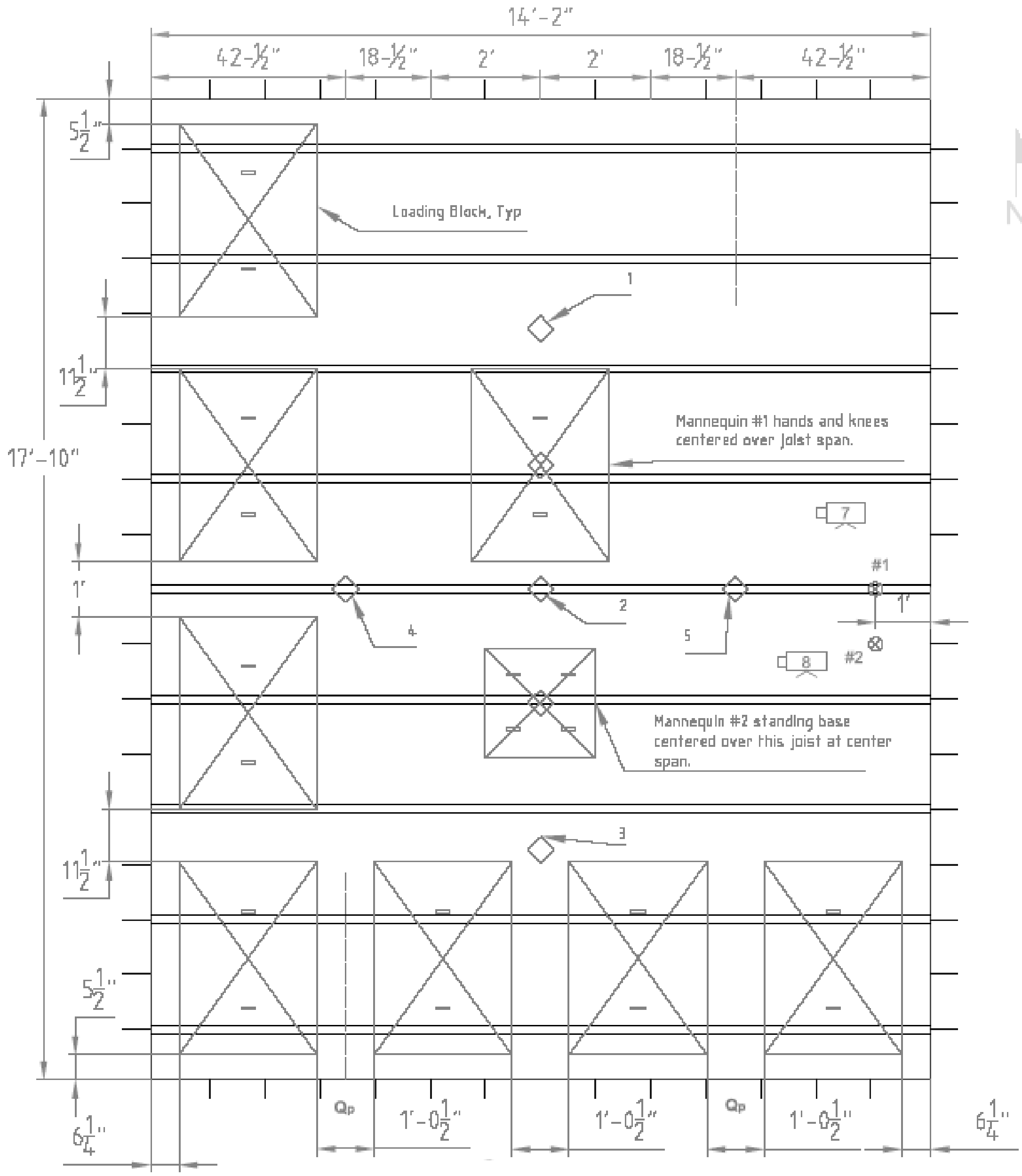


Figure A.4.7 – Loading and Instrumentation Layout (See Figure A.4.8).

Assembly No. 4

Deflection Transducers:

1 - Along E-W Centerline, North Quarter-point.
2 - Along E-W Centerline, Center-point.
3 - Along E-W Centerline, South Quarter-point.
4 - Along N-S Centerline, East Quarter-point.
5 - Along N-S Centerline, West Quarter-point.

Accelerometers:

1- Over Joist, 12 in. from East edge of assembly.
2- Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 - Mannequin No. 1 (Hands & Knees)
2 - Mannequin No. 2 (Standing)

Video Camera Recordings:(Not Shown)

Channel 1409 - floor level view from northeast corner
Channel 1411 - IR camera from curing cell roof east center
Channel 1412 - furnace camera from northwest corner
Channel 1416 - overhead from east center of assembly

Channel 1413 - overhead from south center of assembly
Channel 1503 - overhead from west center of assembly

Video Camera Recordings:

Channel 1415 - internal camera east (installed in joist cavity 6 from north facing west - under kneeling mannequin #1.
Channel 1502 - internal camera east (installed in joist cavity 8 from north facing west -under standing mannequin #2.

Furnace Pressure Probes: (Not Shown)
1 - located near plate thermocouple No. 78
2 - located near plate thermocouple No. 79

Oxygen Content : (Not Shown)
located in E exhaust duct.

Figure A.4.8 – Loading and Instrumentation Key

Assembly No. 5

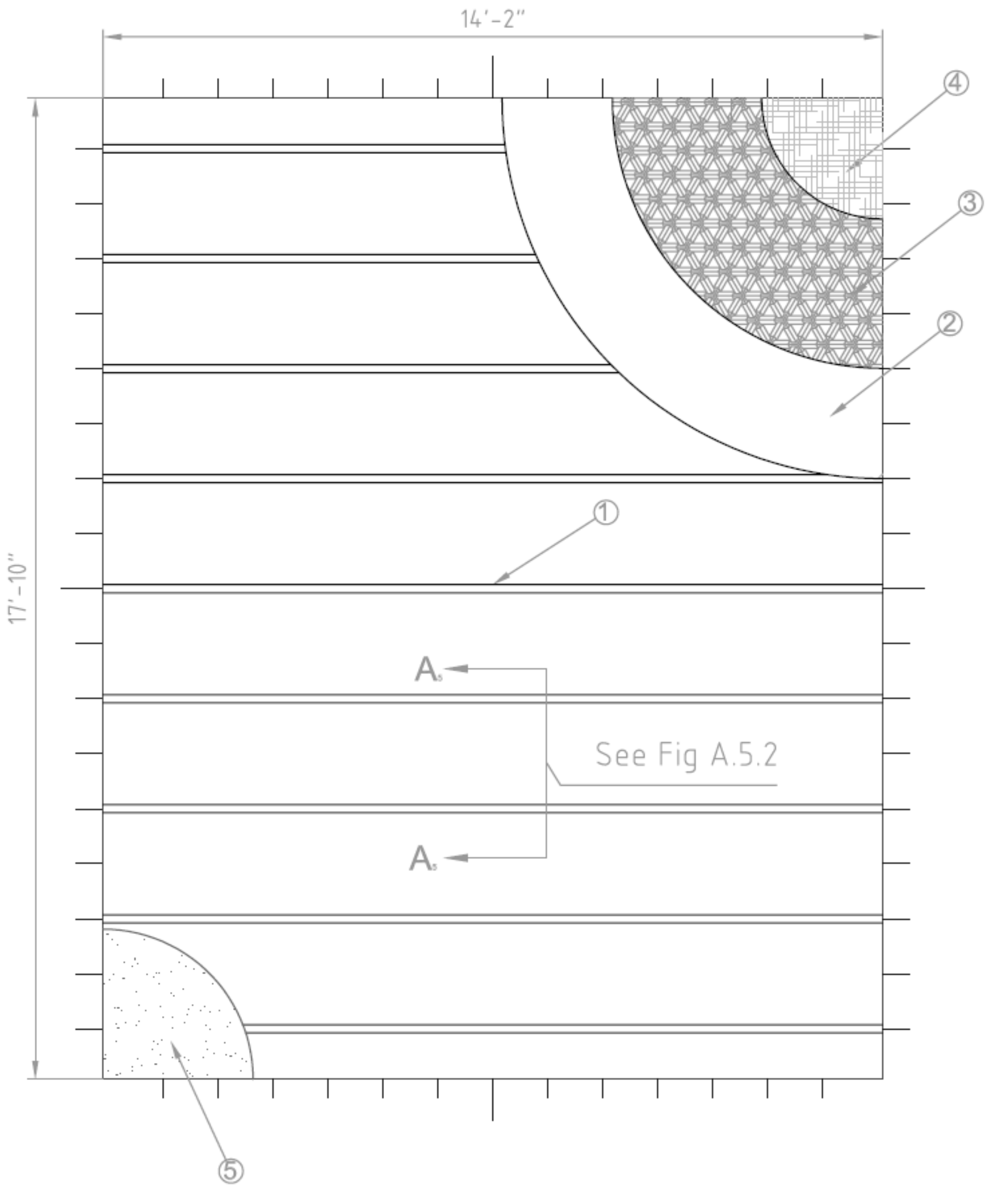


Figure A.5.1 – Construction Layout

Assembly No. 5

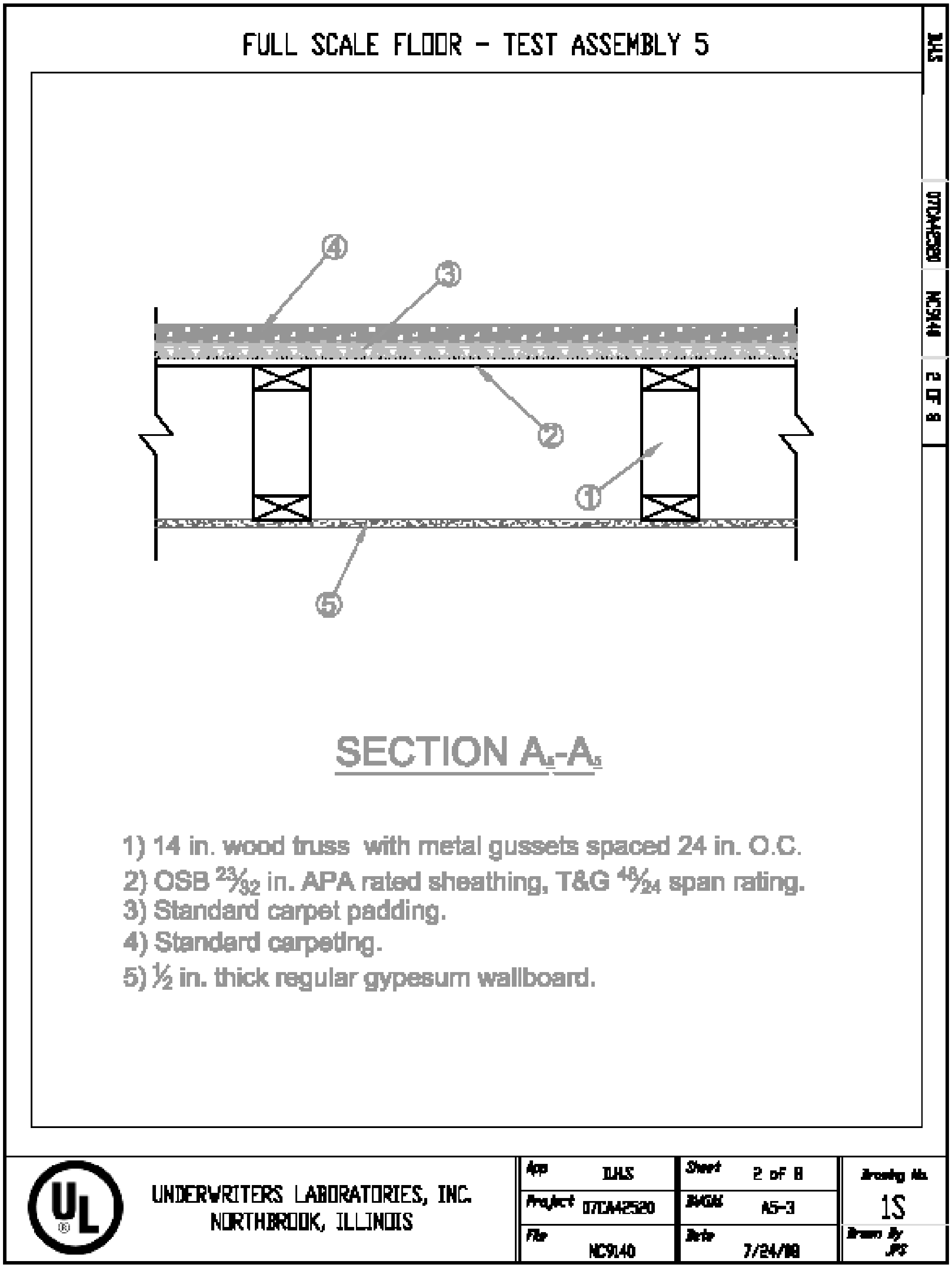


Figure A.5.2 – Construction Layout Section A_5-A_5.

Assembly No. 5

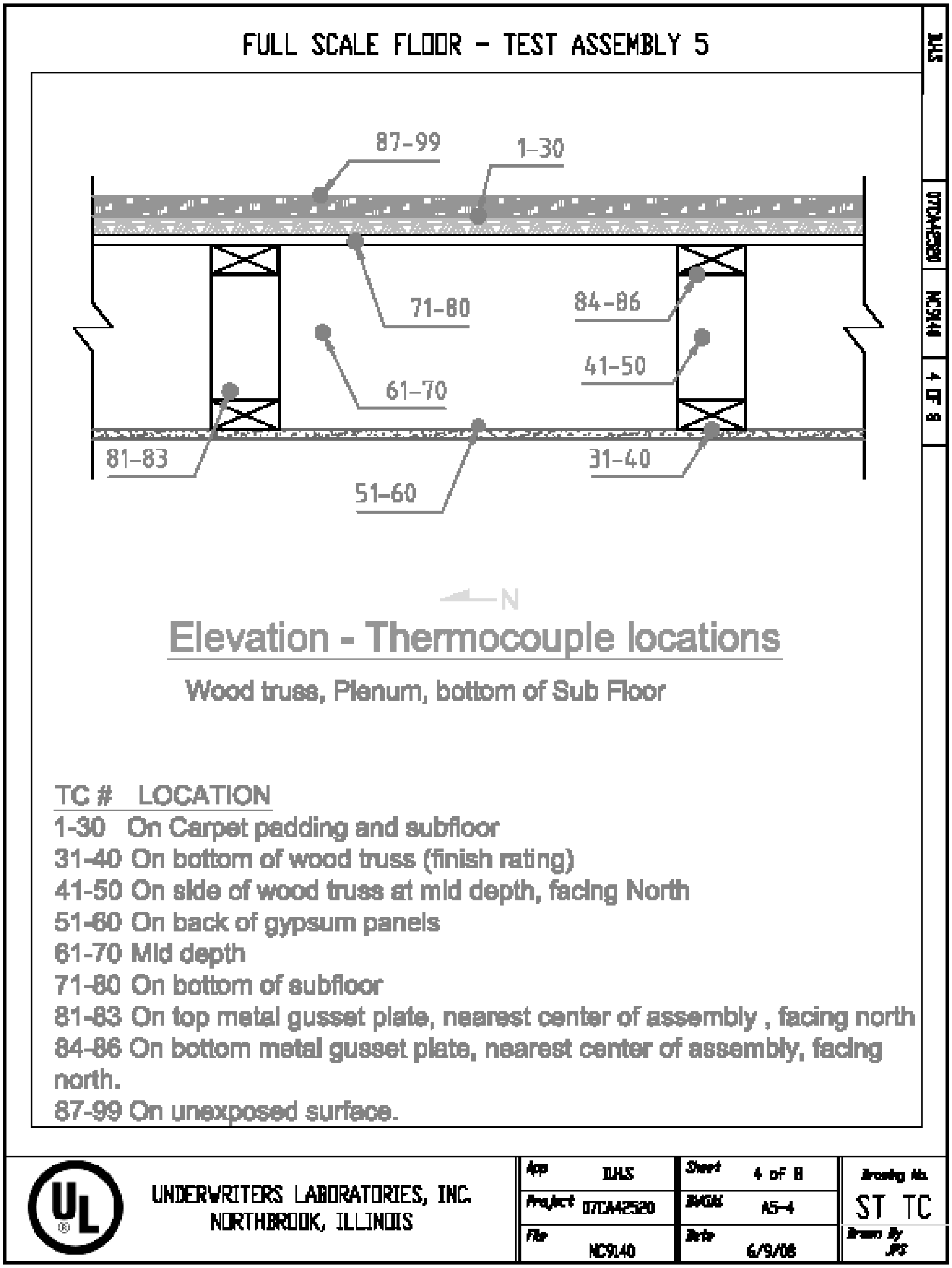


Figure A.5.3 – Thermocouple Locations - Elevation.

Assembly No. 5

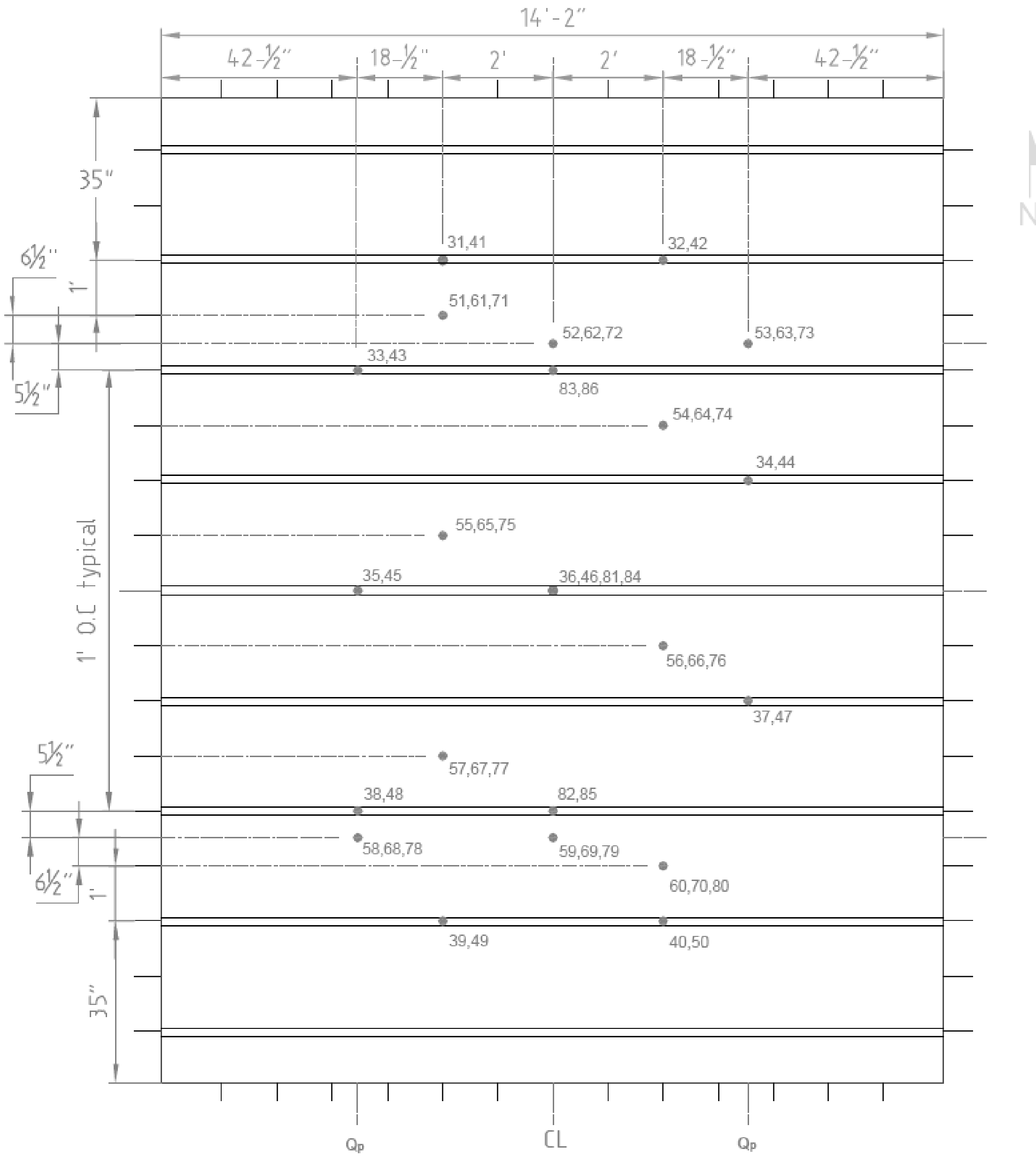


Figure A.5.4 – Thermocouple Locations on Wood Members.

Assembly No. 5

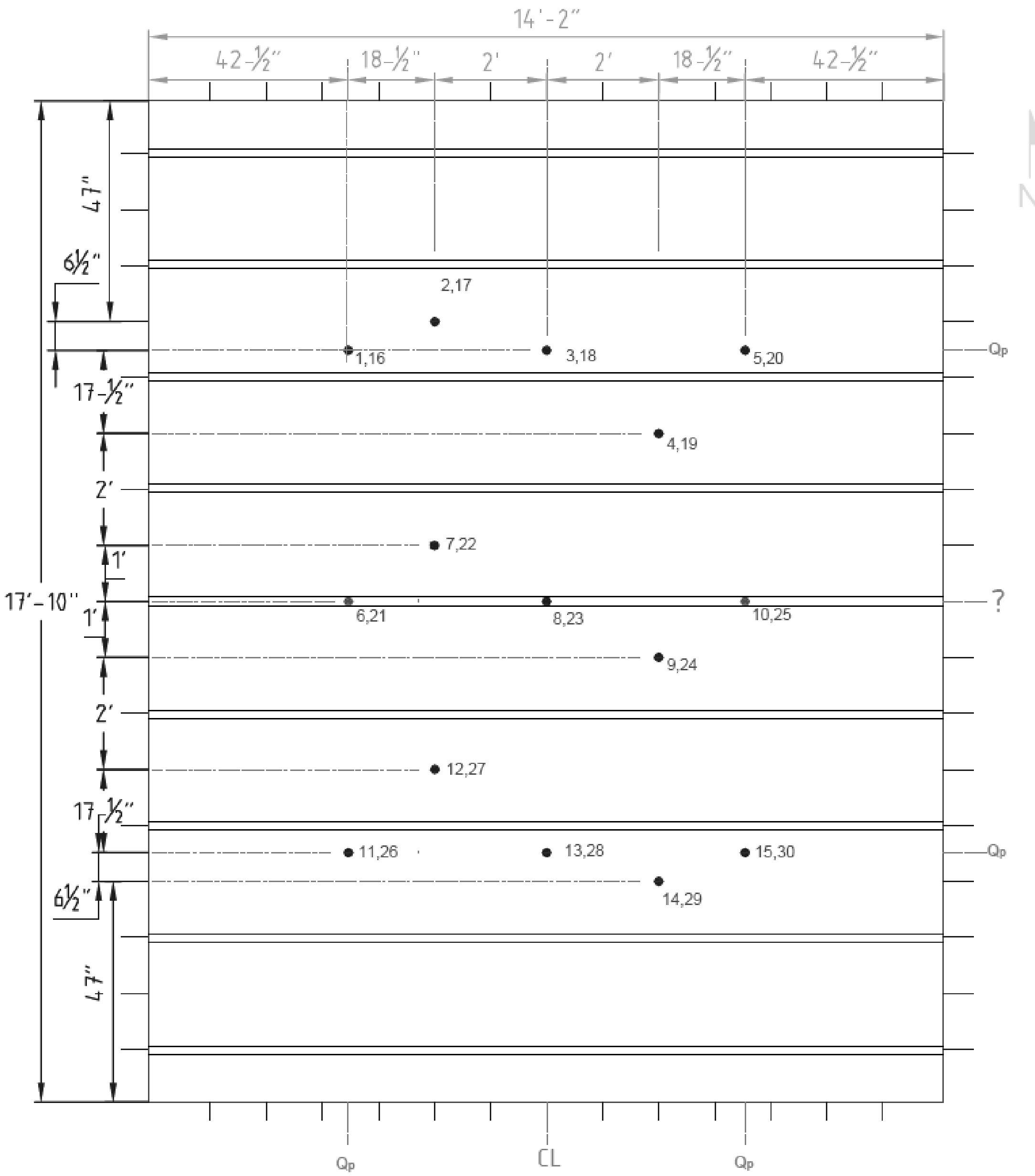


Figure A.5.5 – Thermocouple Locations on Subfloor and Carpet Padding.

Assembly No. 5

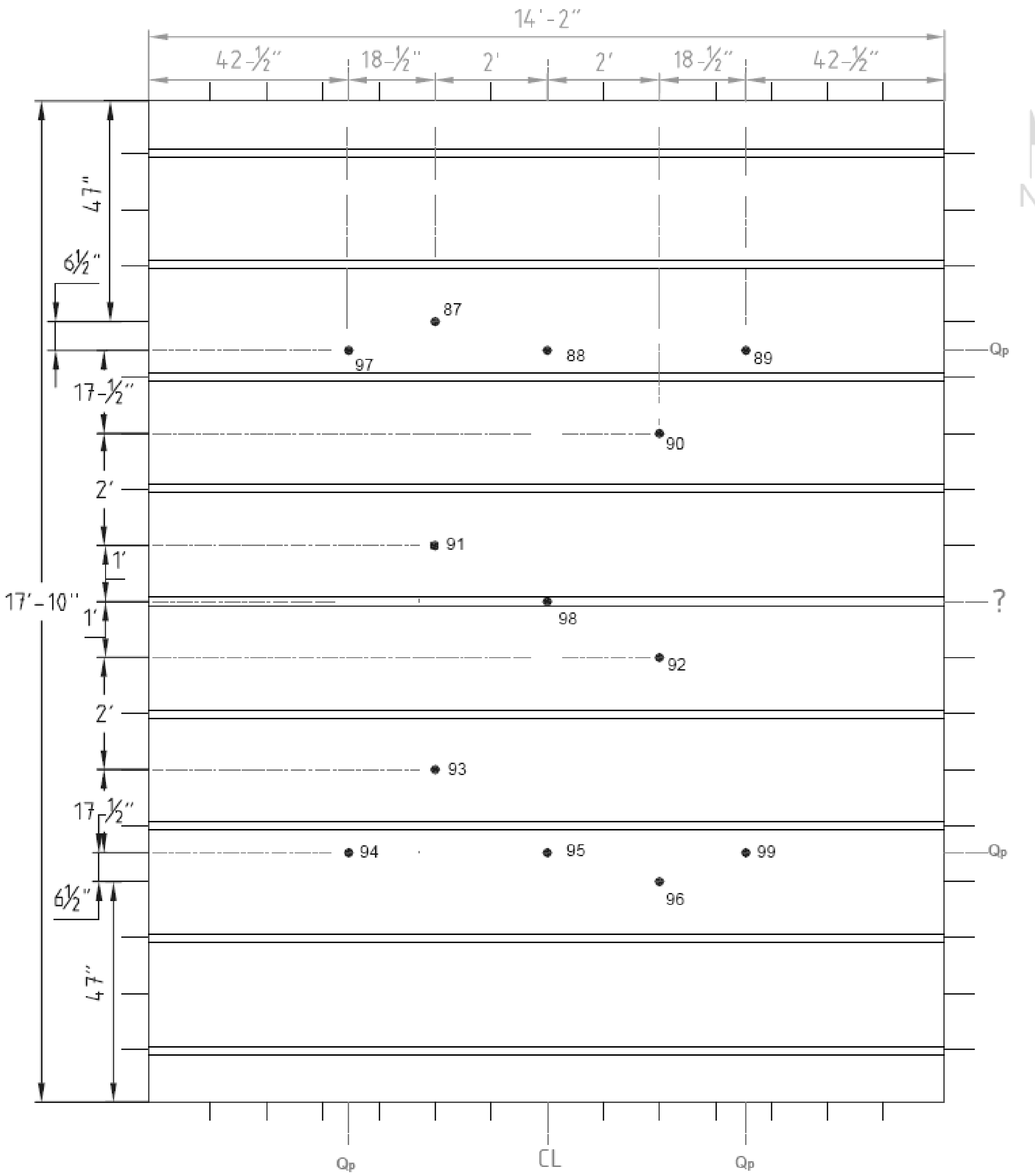


Figure A.5.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 5

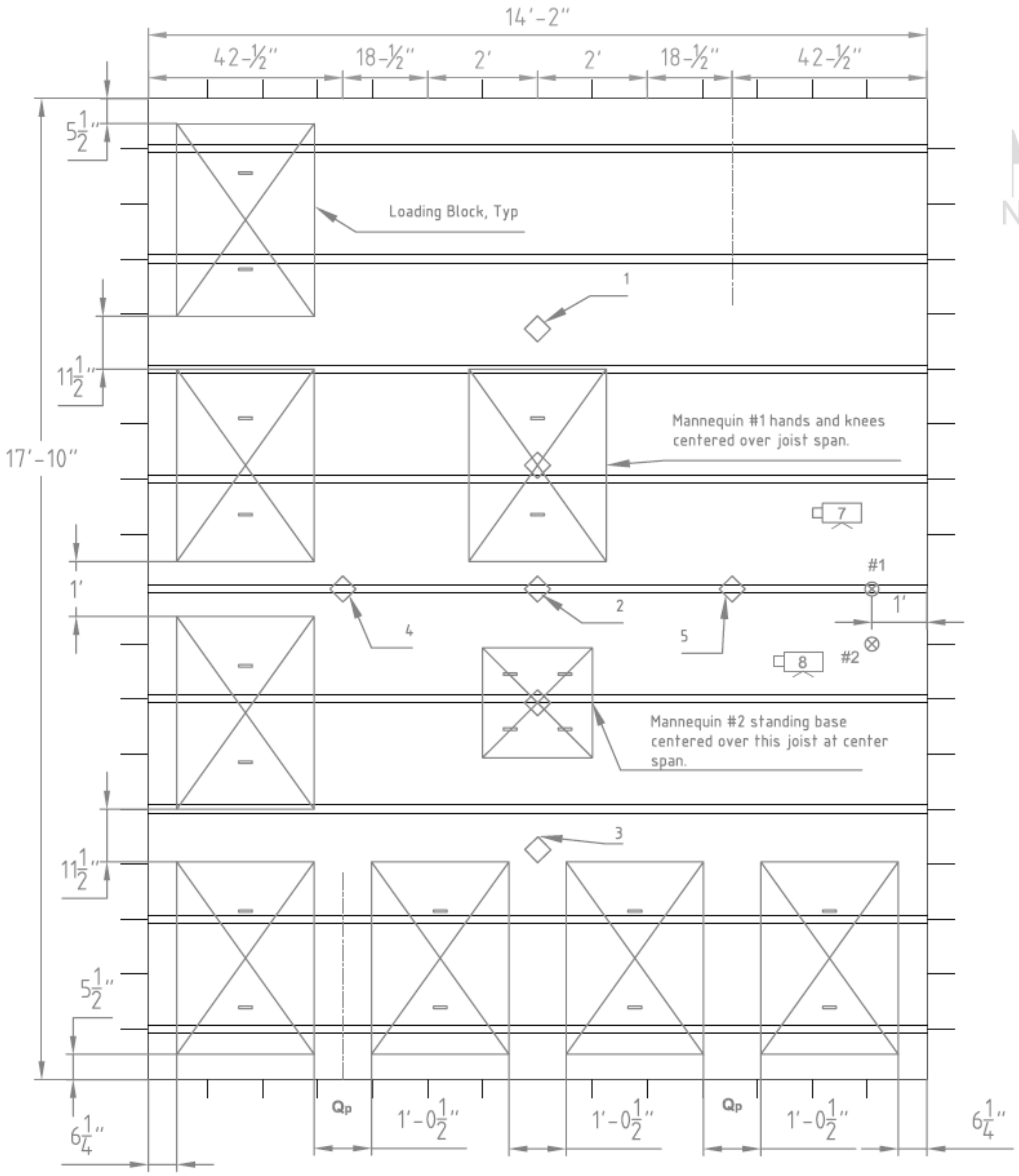


Figure A.5.7 – Loading and Instrumentation Layout (See Figure A.5.8).

Assembly No. 5

Deflection Transducers: ◇

1 - Along E-W Centerline, North Quarter-point.
2 - Along E-W Centerline, Center-point.
3 - Along E-W Centerline, South Quarter-point.
4 - Along N-S Centerline, East Quarter-point.
5 - Along N-S Centerline, West Quarter-point.

Accelerometers: ⊗

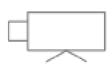
1- Over Joist, 12 in. from East edge of assembly.
2- Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 - Mannequin No. 1 (Hands & Knees)
2 - Mannequin No. 2 (Standing)

Video Camera Recordings: (Not Shown)

#1 - Furnace Camera (Facing South East)
#2 - Floor Level Unexposed Surface View (Facing South)
#3 - Aerial Unexposed Surface View (Facing East, Center Camera)
#4 - Aerial Unexposed Surface View (Facing North, Center Camera)
#5 - Aerial Unexposed Surface View (Facing West, Center Camera)
#6 - Thermal Imaging Aerial Unexposed Surface View (Centered and Facing West)

Video Camera Recordings: 

#7 Concealed space, facing East, towards mannequin #1
#8 Concealed space, facing East, towards mannequin #2

Figure A.5.8 – Loading and Instrumentation Key

Assembly No. 6

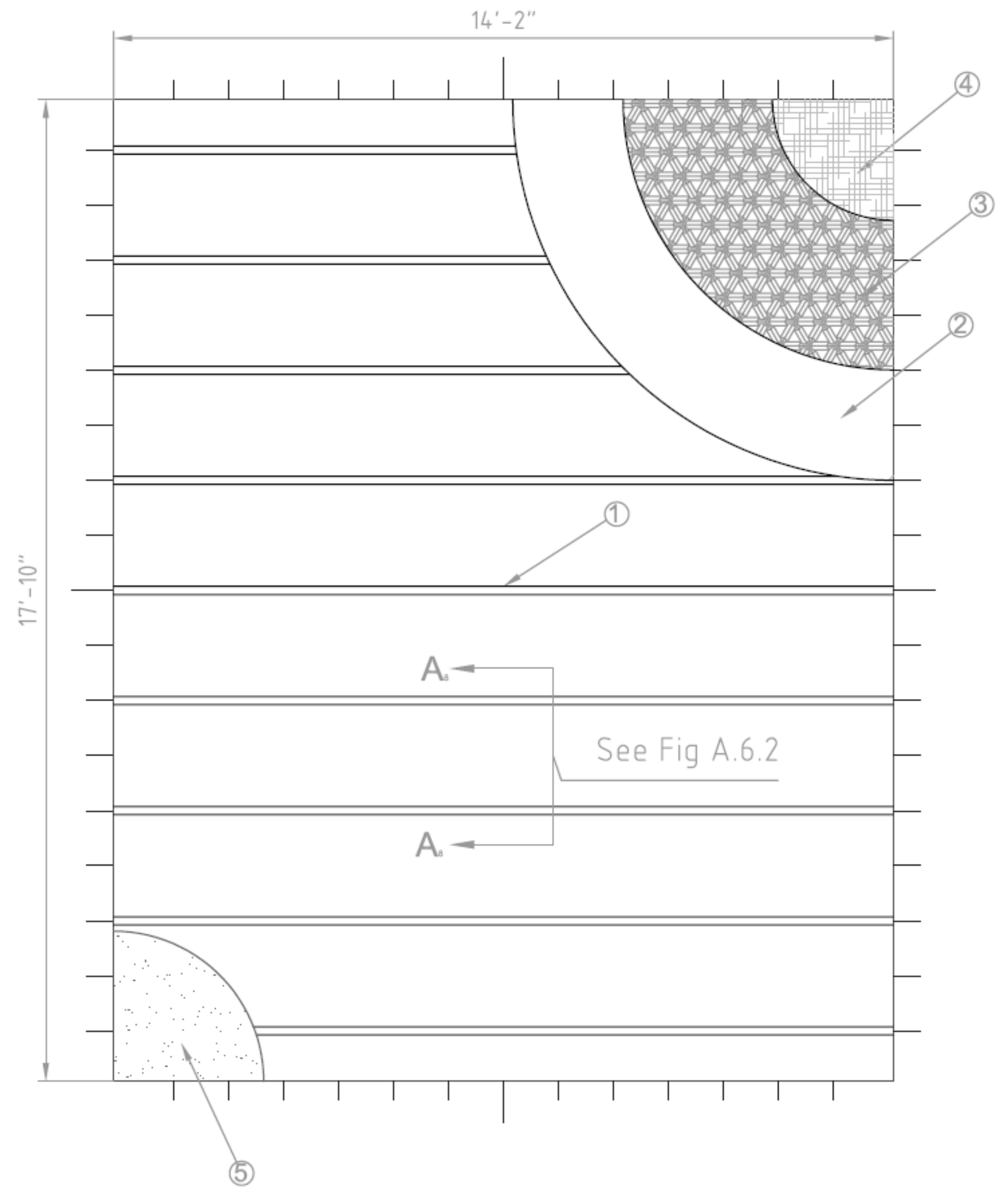
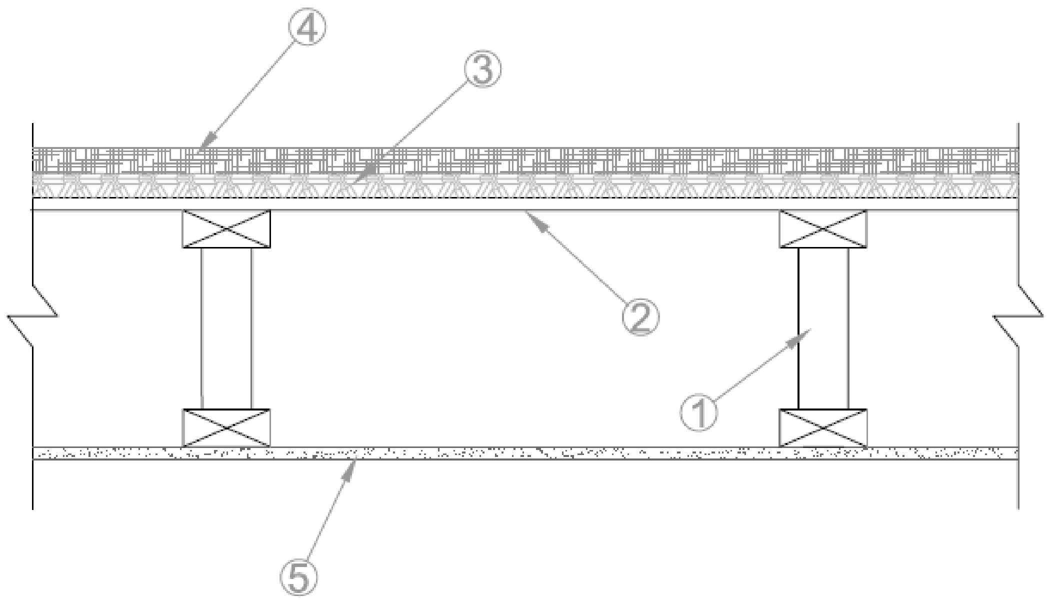


Figure A.6.1 – Construction Layout

Assembly No. 6

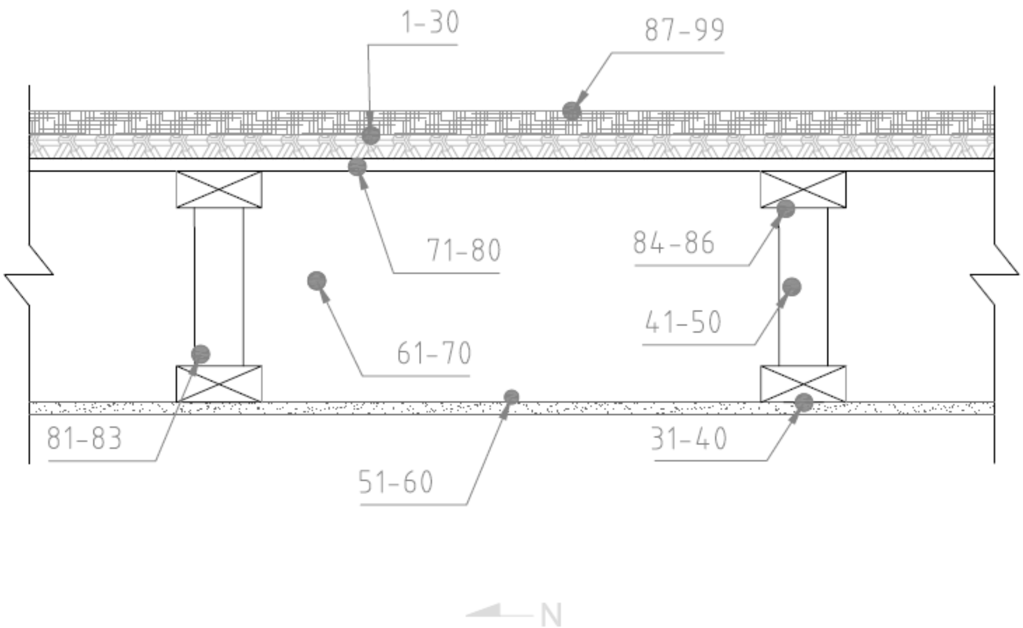


SECTION A_6-A_6

1) 14 in. Deep wood truss with glued finger joints spaced 24 in. O.C.
2) OSB $^{23}/_{32}$ in. APA rated sheathing, T&G $^{48}/_{24}$ span rating.
3) Standard carpet padding.
4) Standard carpeting.
5) ½ in. thick regular gypsum wallboard.

Figure A.6.2 – Construction Layout Section A_6-A_6.

Assembly No. 6



Elevation - Thermocouple Locations

Wood truss, Plenum, bottom of Sub Floor

TC #	LOCATION
1-30	On subfloor and carpet padding
31-40	On bottom of wood truss (finish rating)
41-50	On side of wood truss at mid depth, facing North
51-60	On back of gypsum panels
61-70	Mid depth
71-80	On bottom of subfloor
81-83	On glued finger joint, nearest center of assembly , facing north
84-86	On glued finger joint, nearest center of assembly, facing north
87-99	On unexposed surface

Figure A.6.3 – Thermocouple Locations - Elevation.

Assembly No. 6

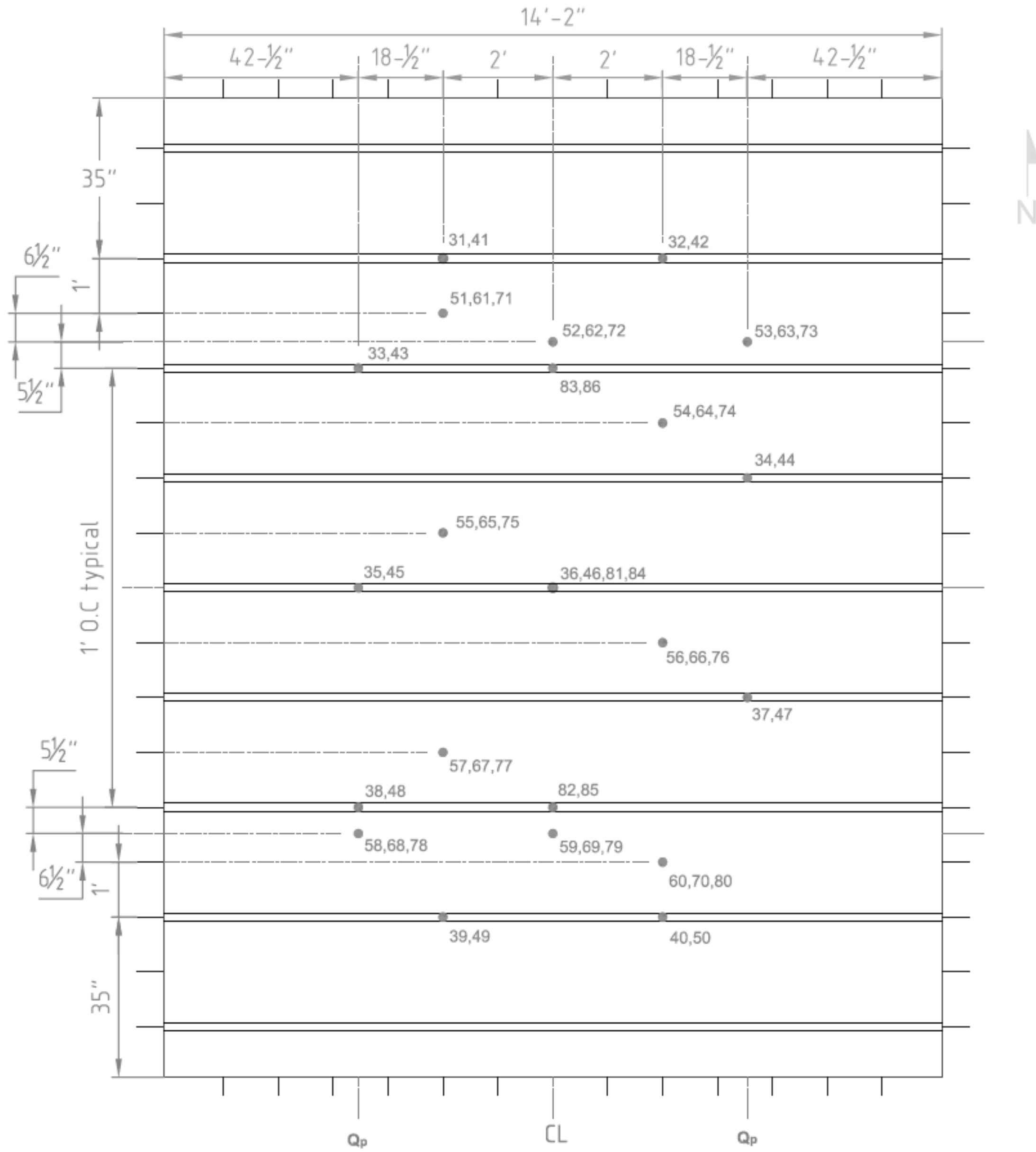


Figure A.6.4 – Thermocouple Locations on Wood Members.

Assembly No. 6

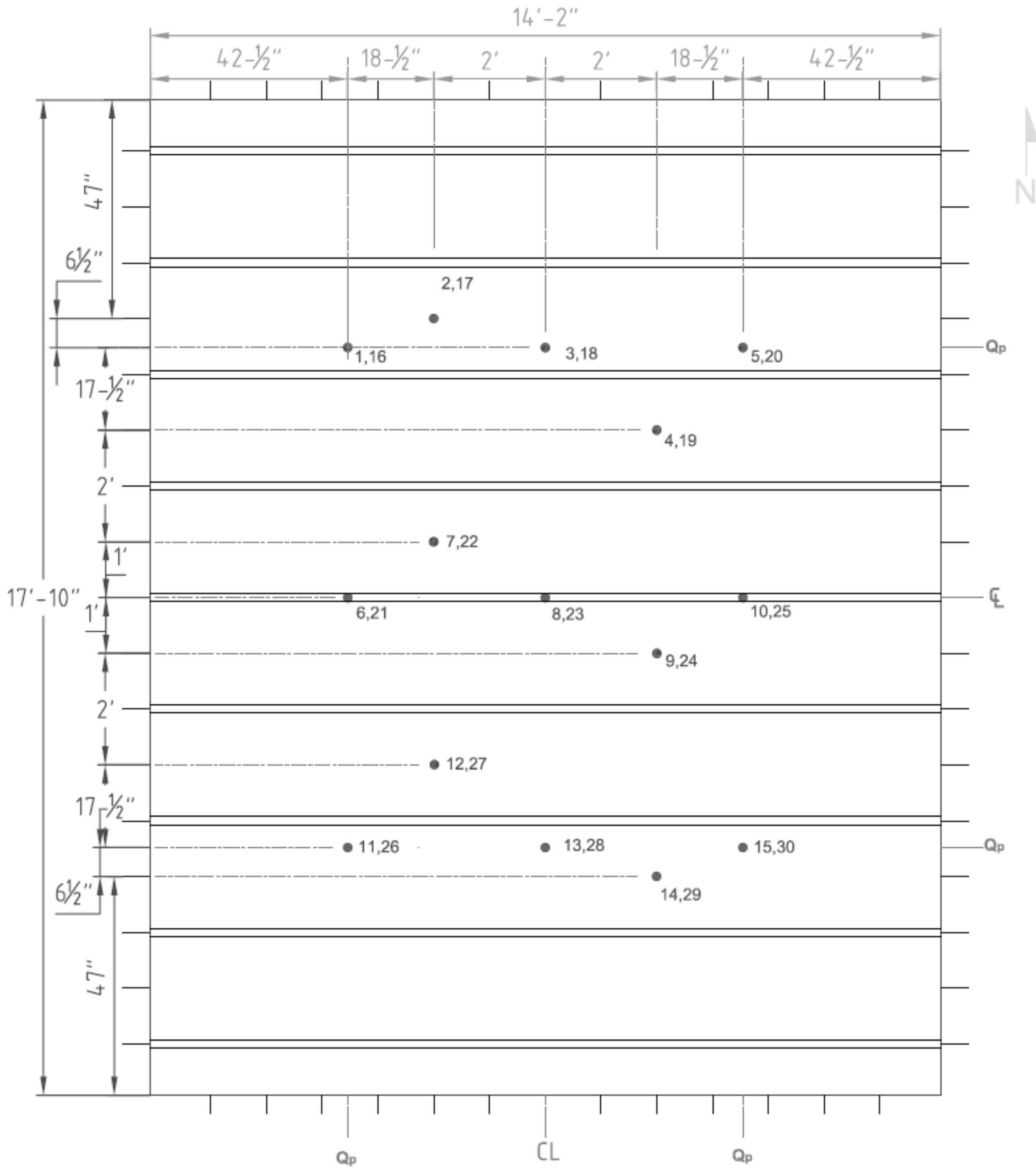


Figure A.6.5 – Thermocouple Locations on Subfloor and Carpet Padding.

Assembly No. 6

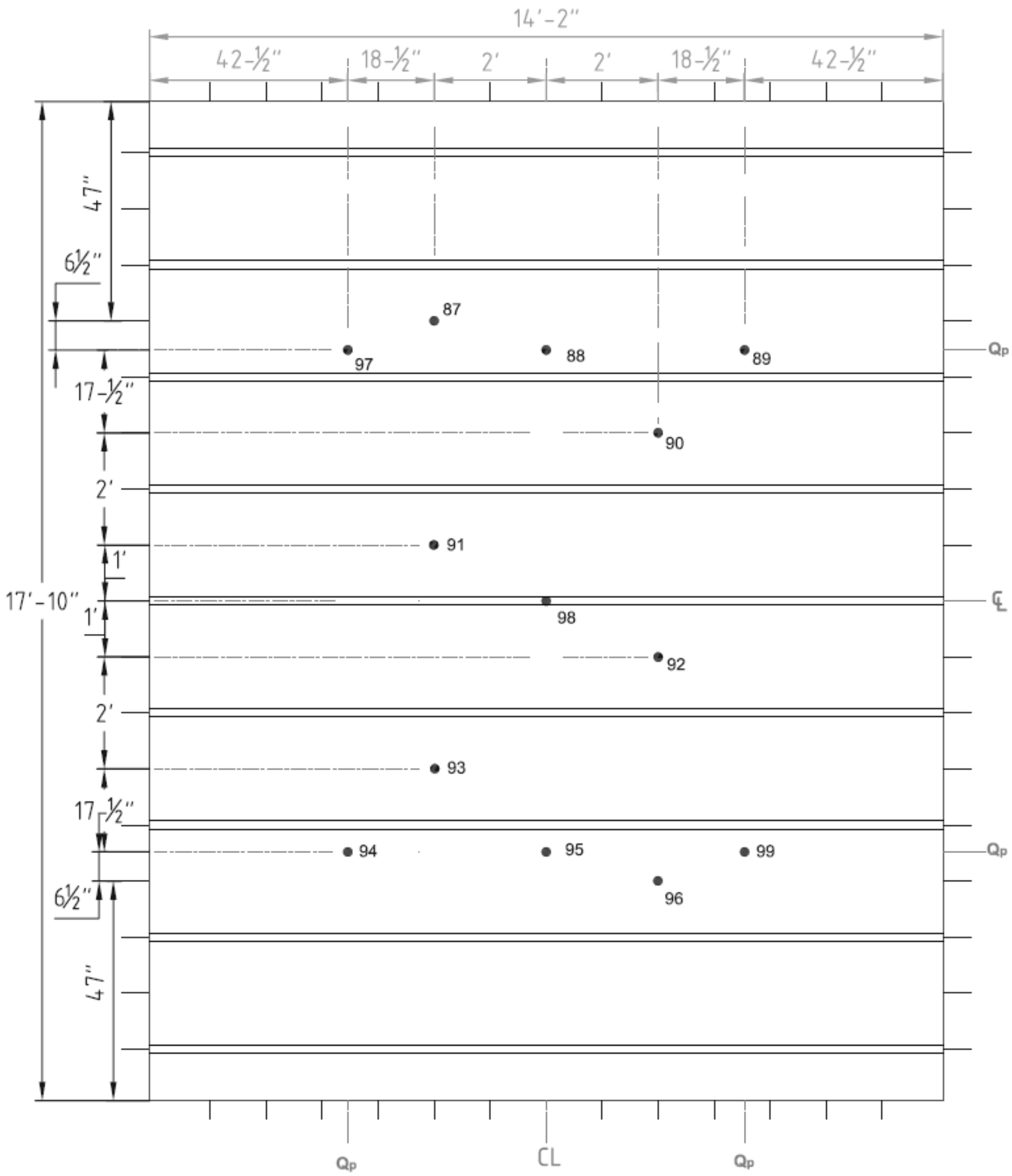


Figure A.6.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 6

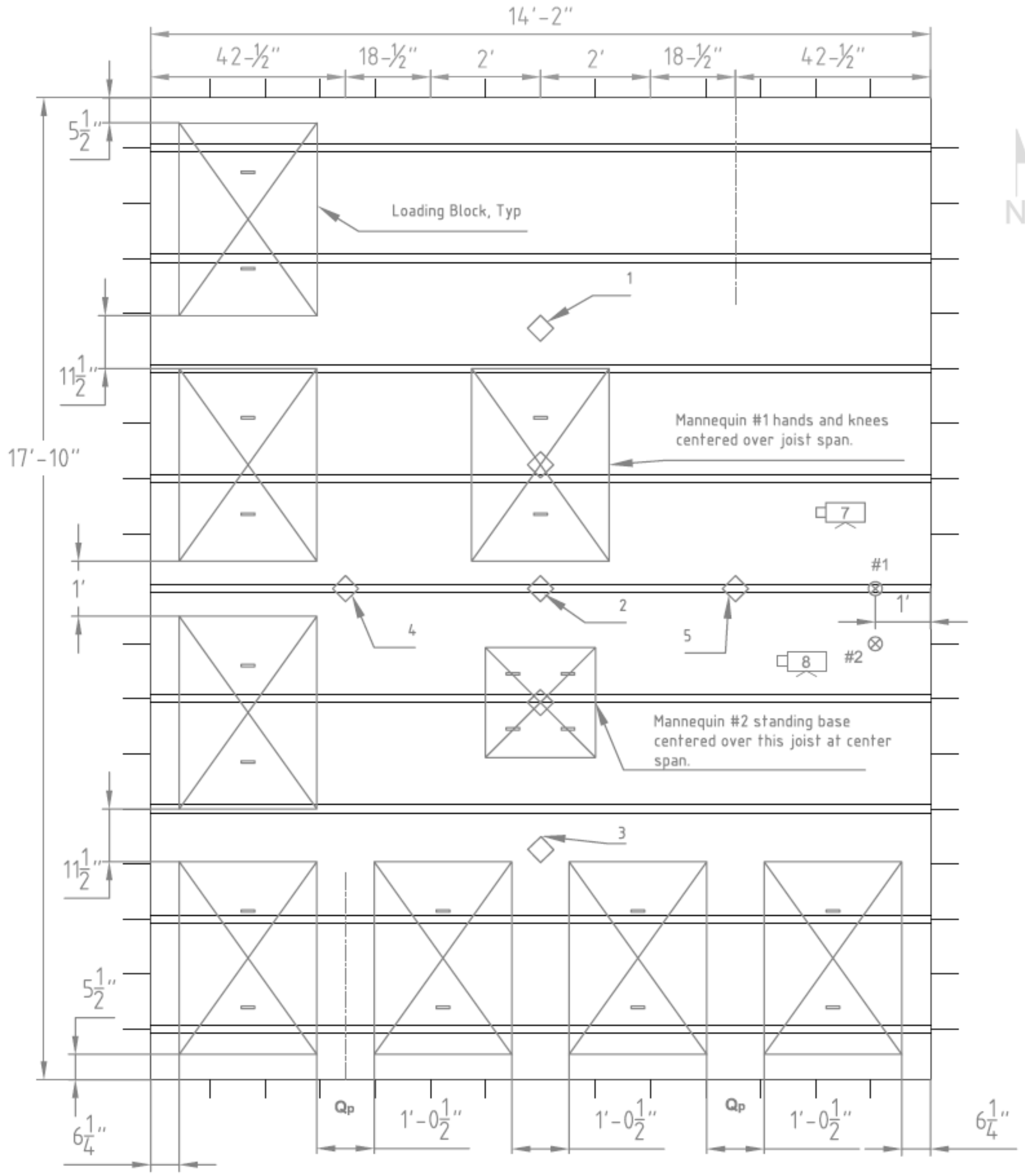


Figure A.6.7 – Loading and Instrumentation Layout (See Figure A.6.8)

Assembly No. 6

Deflection Transducers:

1 – Along E-W Centerline, North Quarter-point.
2 – Along E-W Centerline, Center-point.
3 – Along E-W Centerline, South Quarter-point.
4 – Along N-S Centerline, East Quarter-point.
5 – Along N-S Centerline, West Quarter-point.

Accelerometers:

1– Over Joist, 12 in. from East edge of assembly.
2– Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 – Mannequin No. 1 (Hands & Knees)
2 – Mannequin No. 2 (Standing)

Video Camera Recordings:(Not Shown)

Channel 1409 – floor level view from northeast corner
Channel 1411 – IR camera from curing cell roof east center
Channel 1412 – furnace camera from northwest corner
Channel 1416 – overhead from east center of assembly
Channel 1413 – overhead from south center of assembly
Channel 1503 – overhead from west center of assembly

Video Camera Recordings:

Channel 1415 – internal camera east (installed in joist cavity 6 from north facing west – under kneeling annequin #1.

Channel 1502 – internal camera east (installed in joist cavity 8 from north facing west –under standing mannequin #2.

Furnace Pressure Probes: (Not Shown)
1 – located near plate thermocouple No. 100
2 – located near plate thermocouple No. 101

Oxygen Content : (Not Shown)
located in E exhaust duct.

Figure A.6.8 – Loading and Instrumentation Key

Assembly No. 7

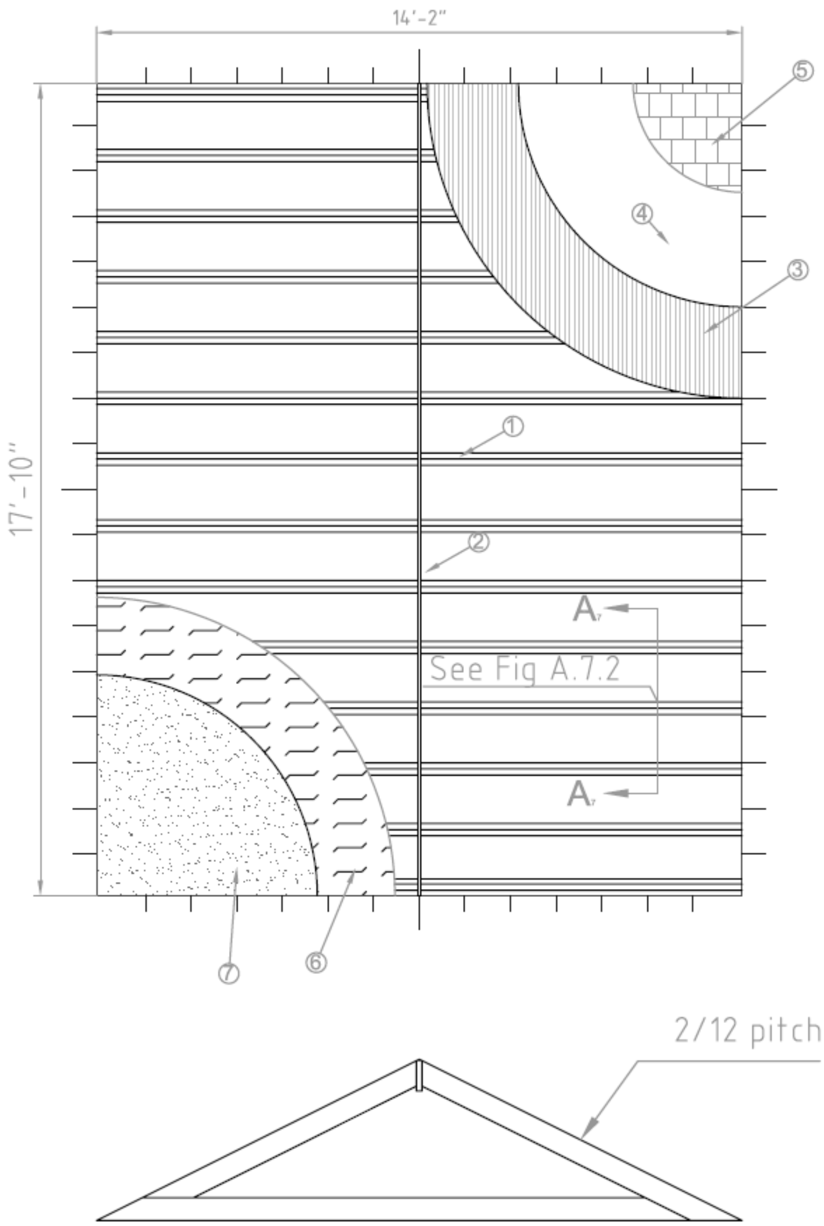


Figure A.7.1 – Construction Layout

Assembly No. 7

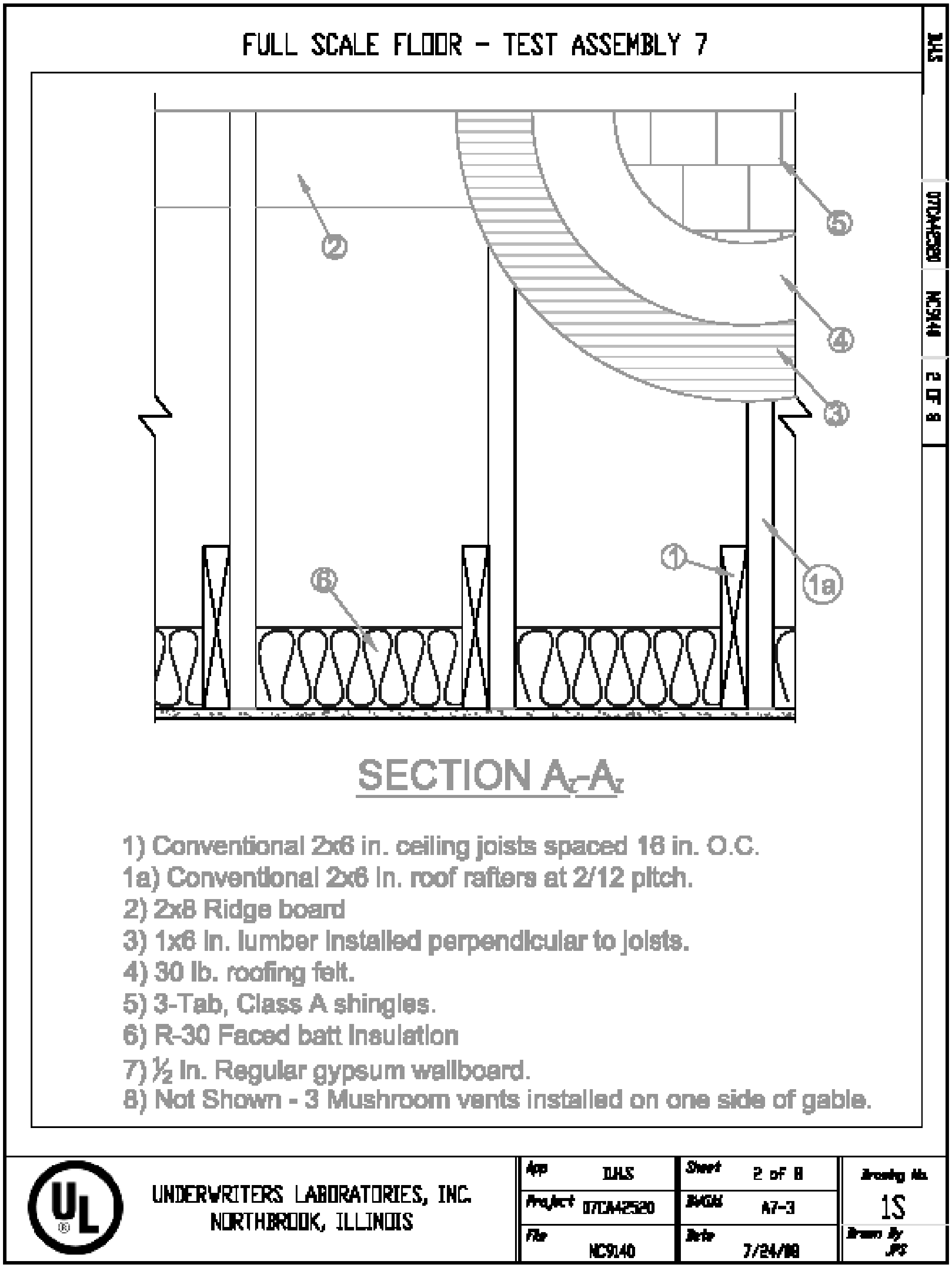
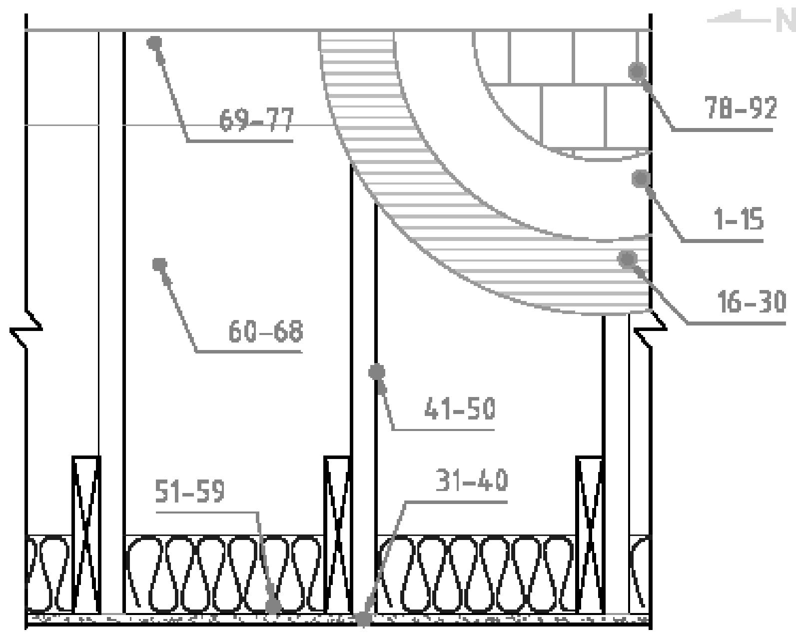


Figure A.7.2 – Construction Layout Section A_7-A_7.

Assembly No. 7

FULL SCALE FLOOR – TEST ASSEMBLY 7



Elevation - Thermocouple Locations

Joists, Rafters, Plenum, bottom of Roof decking

TC #	LOCATION
1-15	On roof felt
16-30	On roof deck
31-40	On bottom of 2X6 Joist (finish rating)
41-50	On side of 2X6 rafter at mid depth, facing North
51-59	On back of gypsum panels
60-68	Mid depth
69-77	On bottom of 1 X 6 lumber
78-92	On unexposed surface.

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UNDERWRITERS LABORATORIES, INC.
NORTHBROOK, ILLINOIS

App IHS	Sheet 4 of 8	Drawing No. ST TC
Project 07CA42520	DWG# A7-4	
File NC9140	Date 6/9/08	Drawn By JFS

Figure A.7.3 – Thermocouple Locations - Elevation.

Assembly No. 7

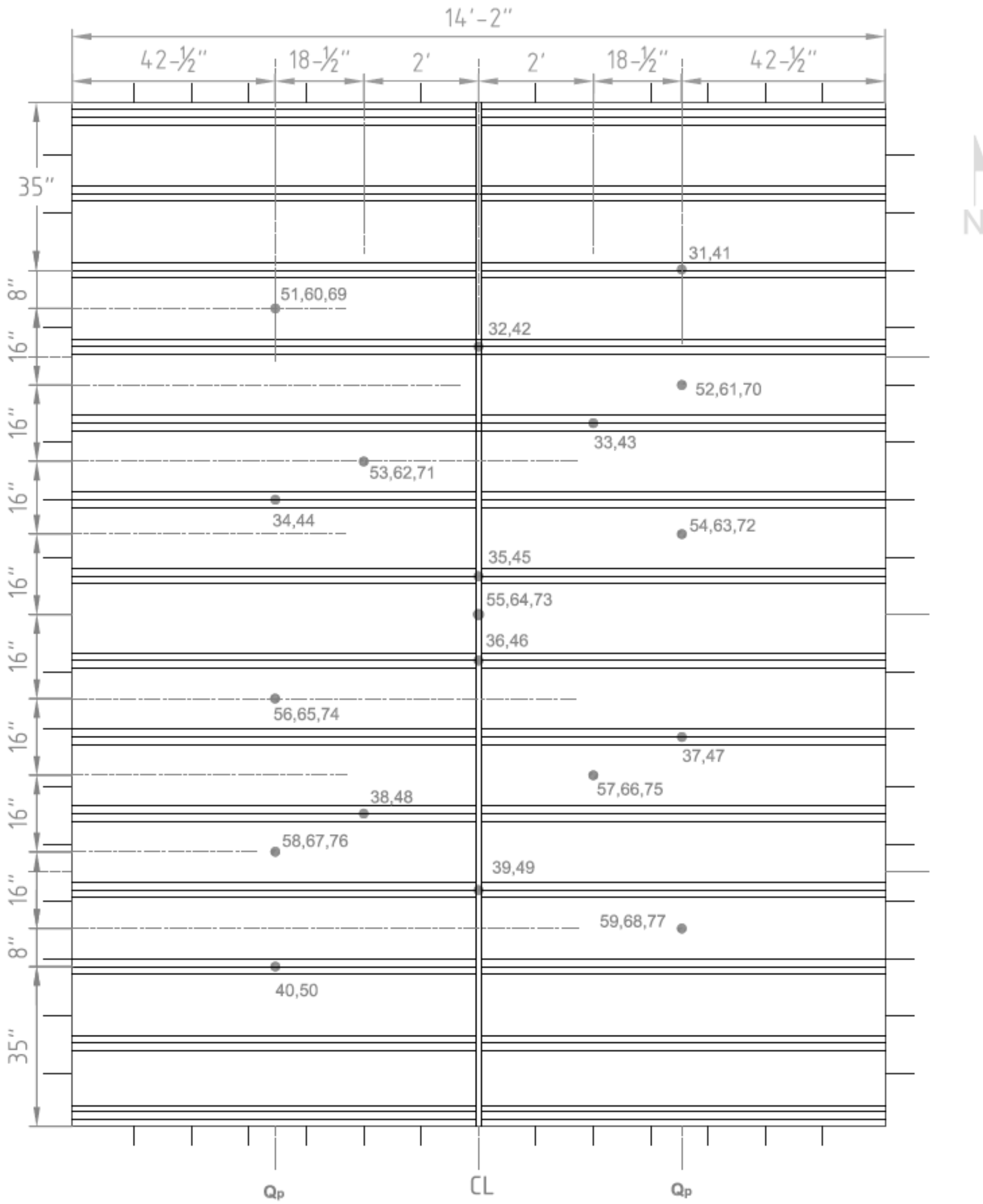


Figure A.7.4 – Thermocouple Locations on Wood Members.

Assembly No. 7

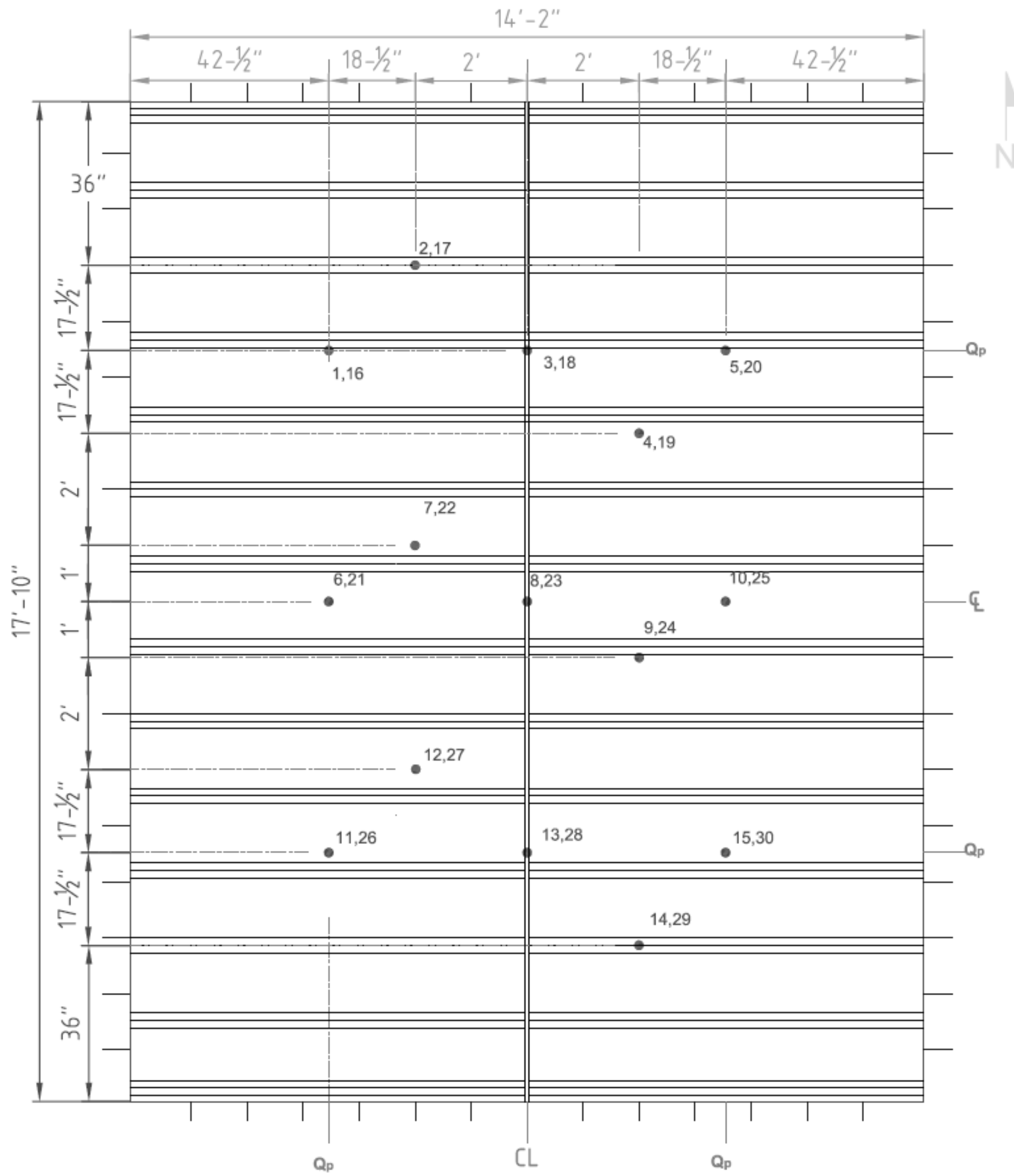
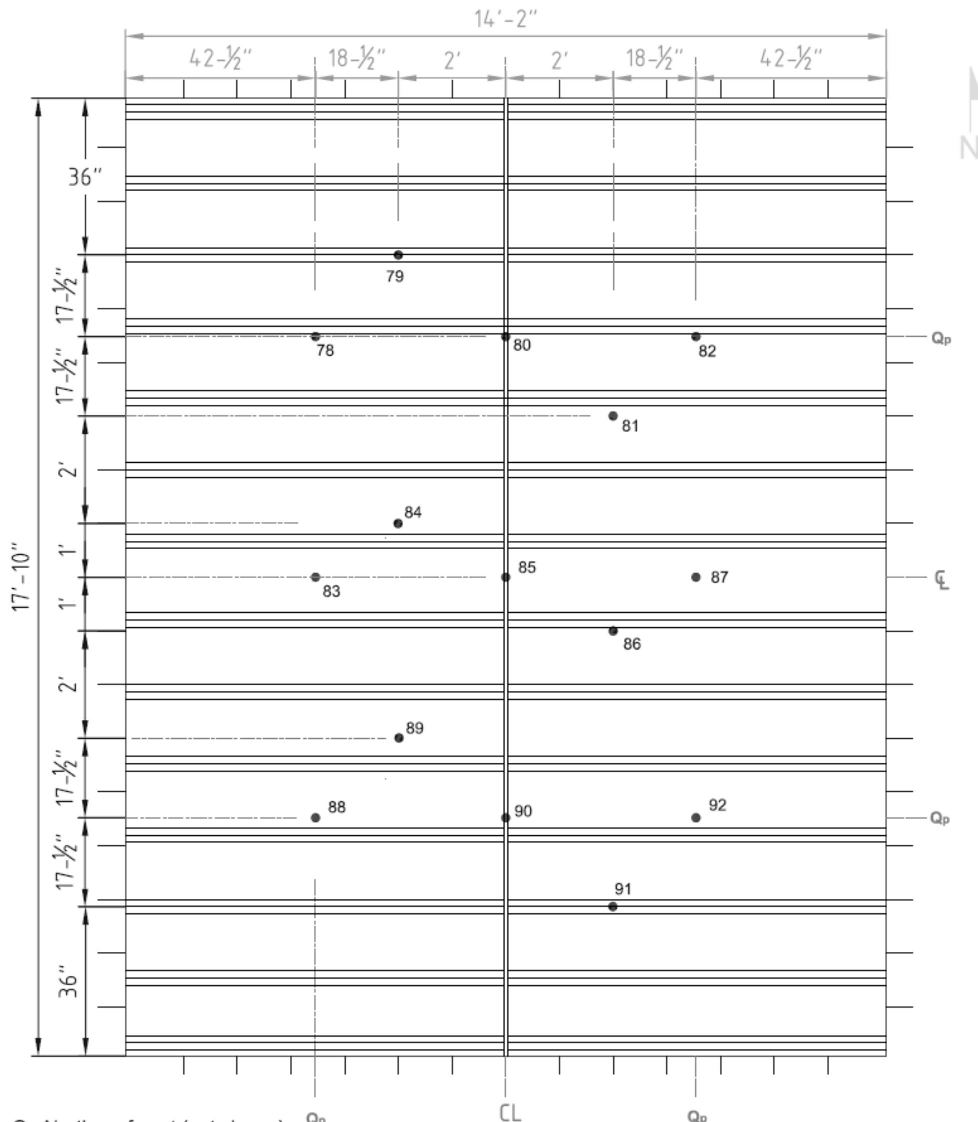


Figure A.7.5 – Thermocouple Locations on Roof Deck and Roof Felt.

Assembly No. 7



93 - On North roof vent (not shown)
94 - On Center roof vent (not shown)
95 - On South roof vent (not shown)

Figure A.7.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 7

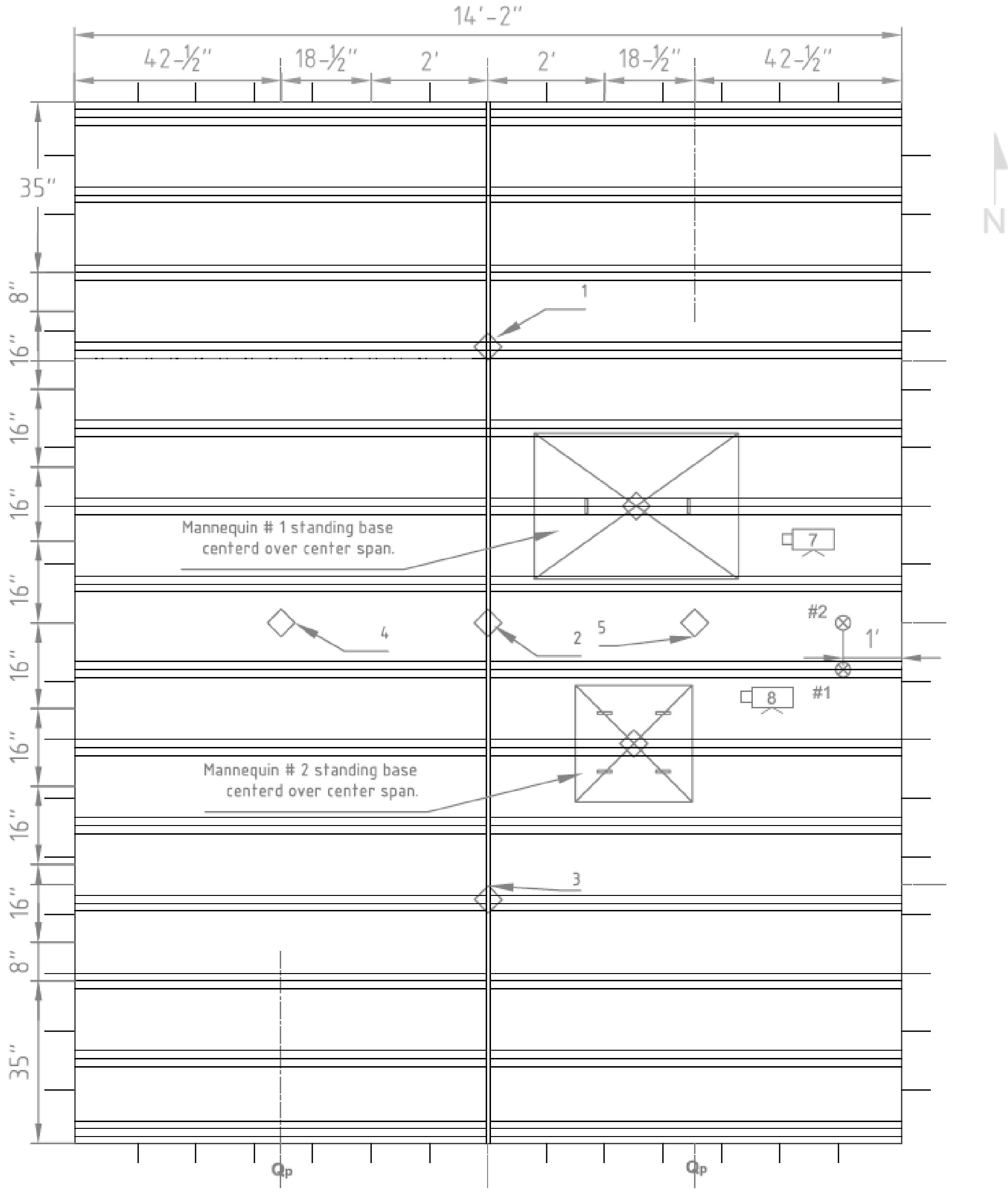


Figure A.7.7 – Loading and Instrumentation Layout (See Figure A.7.8).

Assembly No. 7

Deflection Transducers: ◇

1 - Along E-W Centerline, North Quarter-point.
2 - Along E-W Centerline, Center-point.
3 - Along E-W Centerline, South Quarter-point.
4 - Along N-S Centerline, East Quarter-point.
5 - Along N-S Centerline, West Quarter-point.

Accelerometers: ⊗

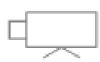
1- Over rafter, 12 in. from East edge of assembly.
2- Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 - Mannequin No. 1 (Hands & Knees)
2 - Mannequin No. 2 (Standing)

Video Camera Recordings:(Not Shown)

Channel 1409 - floor level view from northeast corner
Channel 1411 - IR camera from curing cell roof east center
Channel 1412 - furnace camera from northwest corner
Channel 1416 - overhead from east center of assembly
Channel 1413 - overhead from south center of assembly
Channel 1503 - overhead from west center of assembly

Video Camera Recordings: 

Channel 1415 - internal camera east (installed in joist cavity 6 from north facing west - under kneeling annequin #1.

Channel 1502 - internal camera east (installed in joist cavity 8 from north facing west -under standing mannequin #2.

Furnace Pressure Probes: (Not Shown)
1 - located near plate thermocouple No. 96
2 - located near plate thermocouple No. 97

Oxygen Content : (Not Shown)
located in E exhaust duct.

Figure A.7.8 – Loading and Instrumentation Key

Assembly No. 8

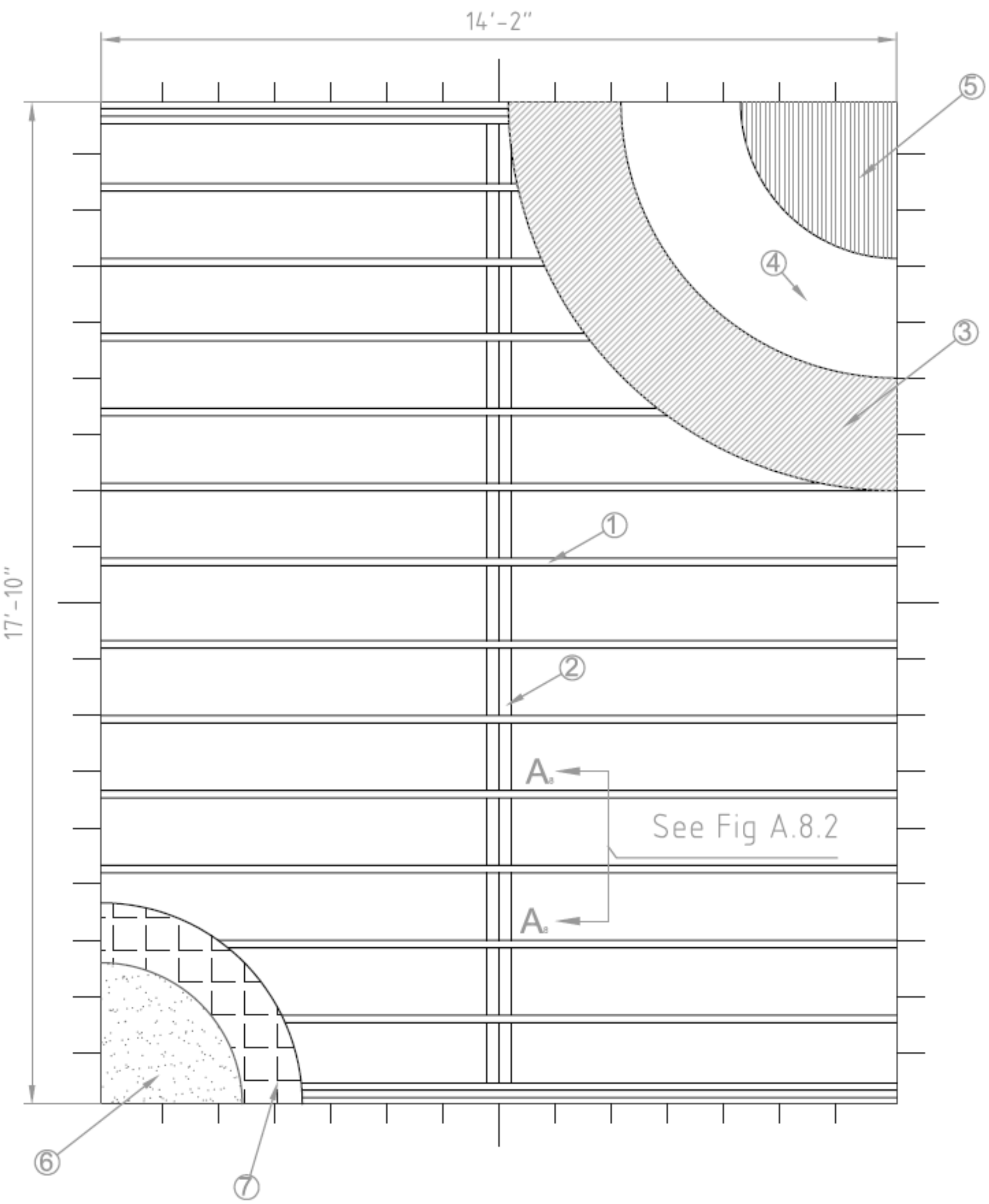


Figure A.8.1 – Construction Layout

Assembly No. 8

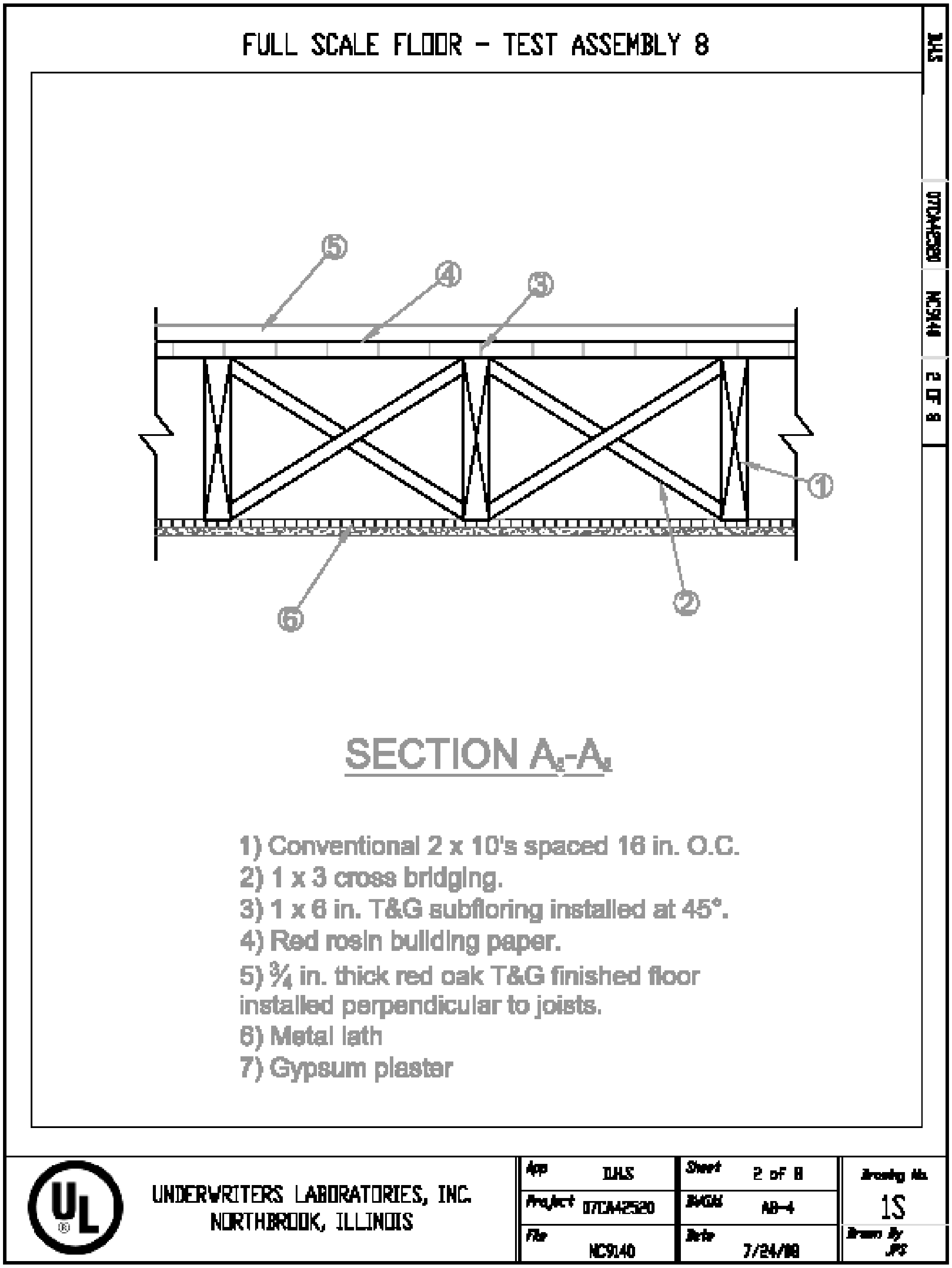


Figure A.8.2 – Construction Layout Section A_8-A_8.

Assembly No. 8

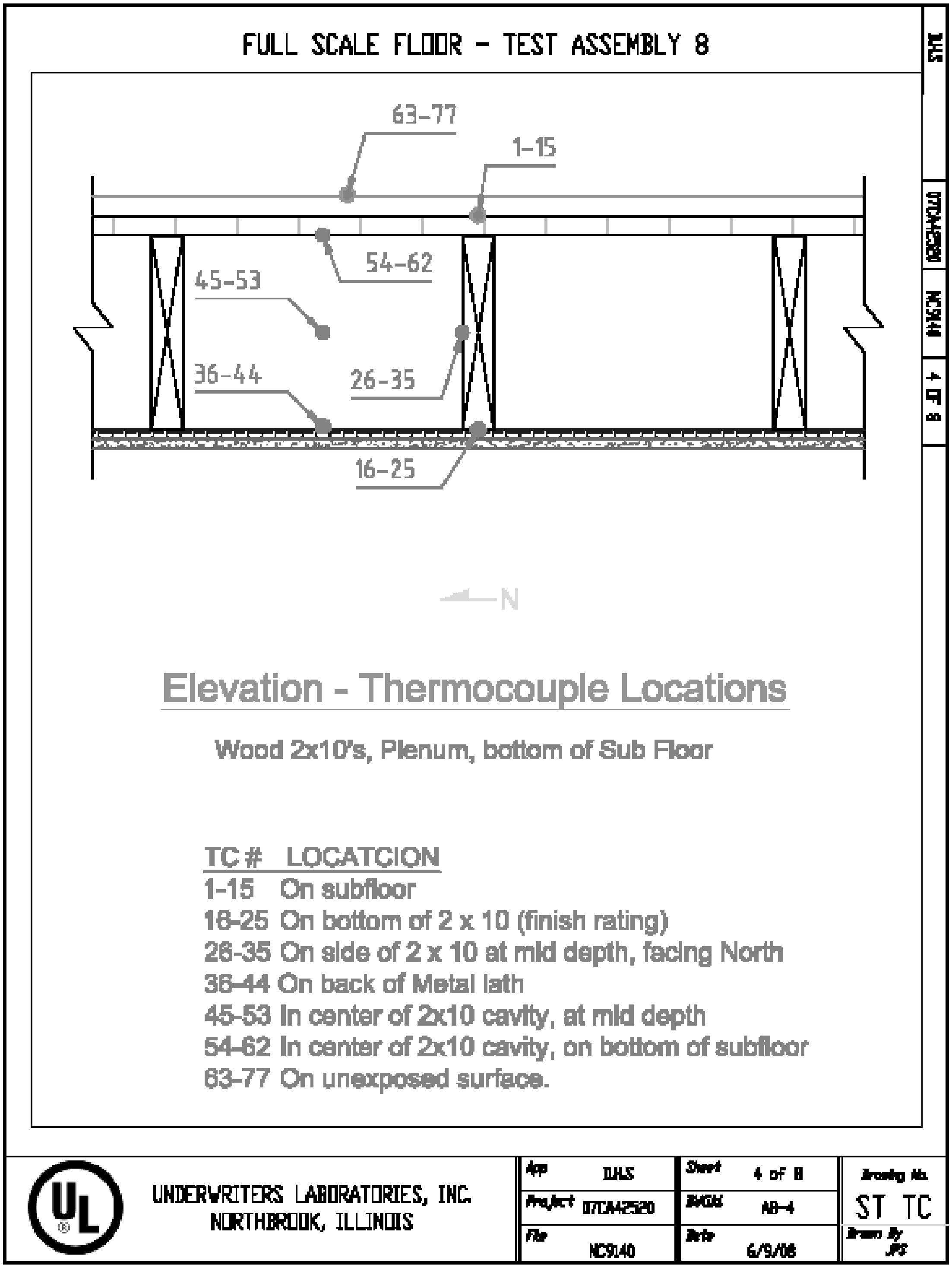


Figure A.8.3 – Thermocouple Locations - Elevation.

Assembly No. 8

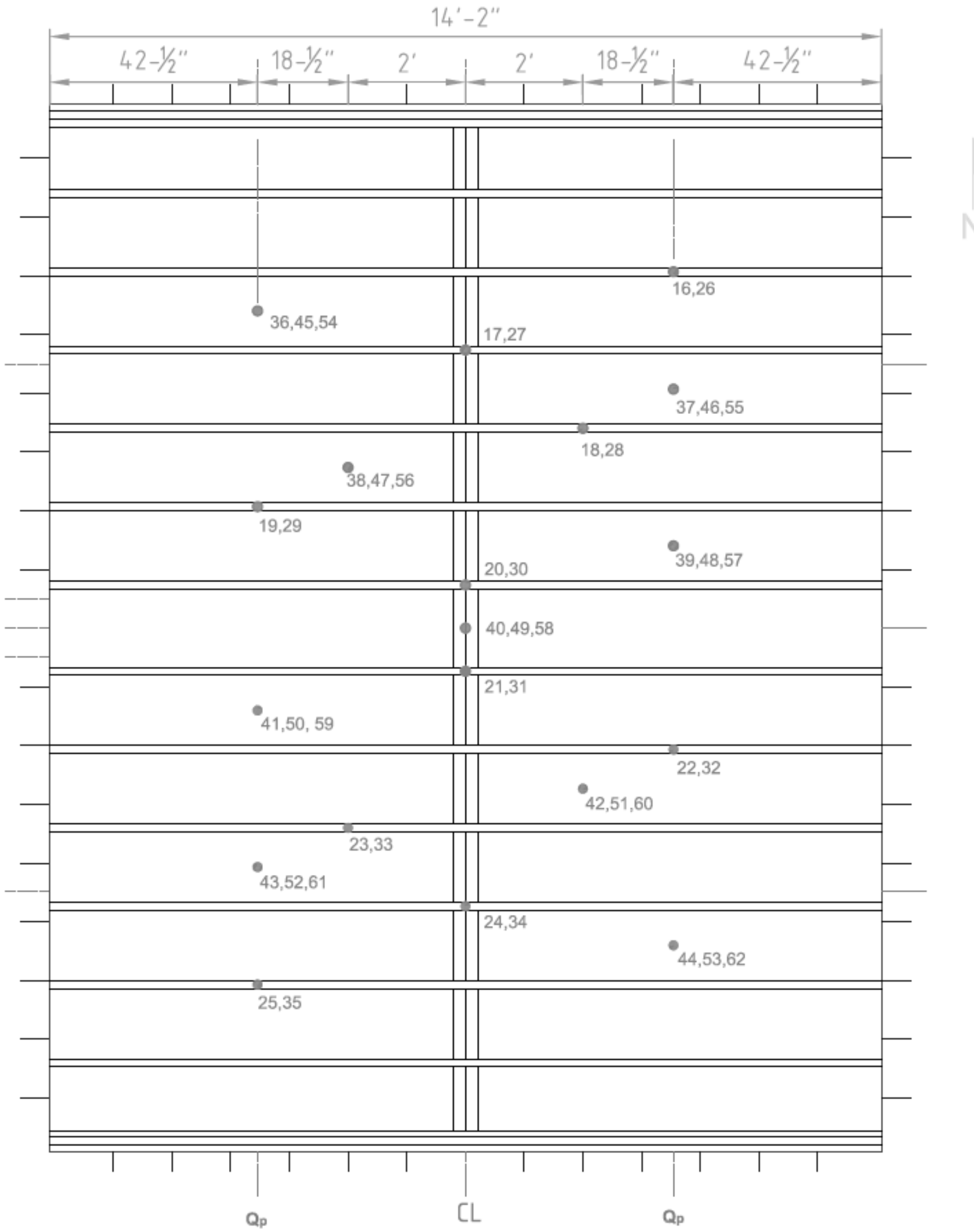


Figure A.8.4 – Thermocouple Locations on Wood Members.

Assembly No. 8

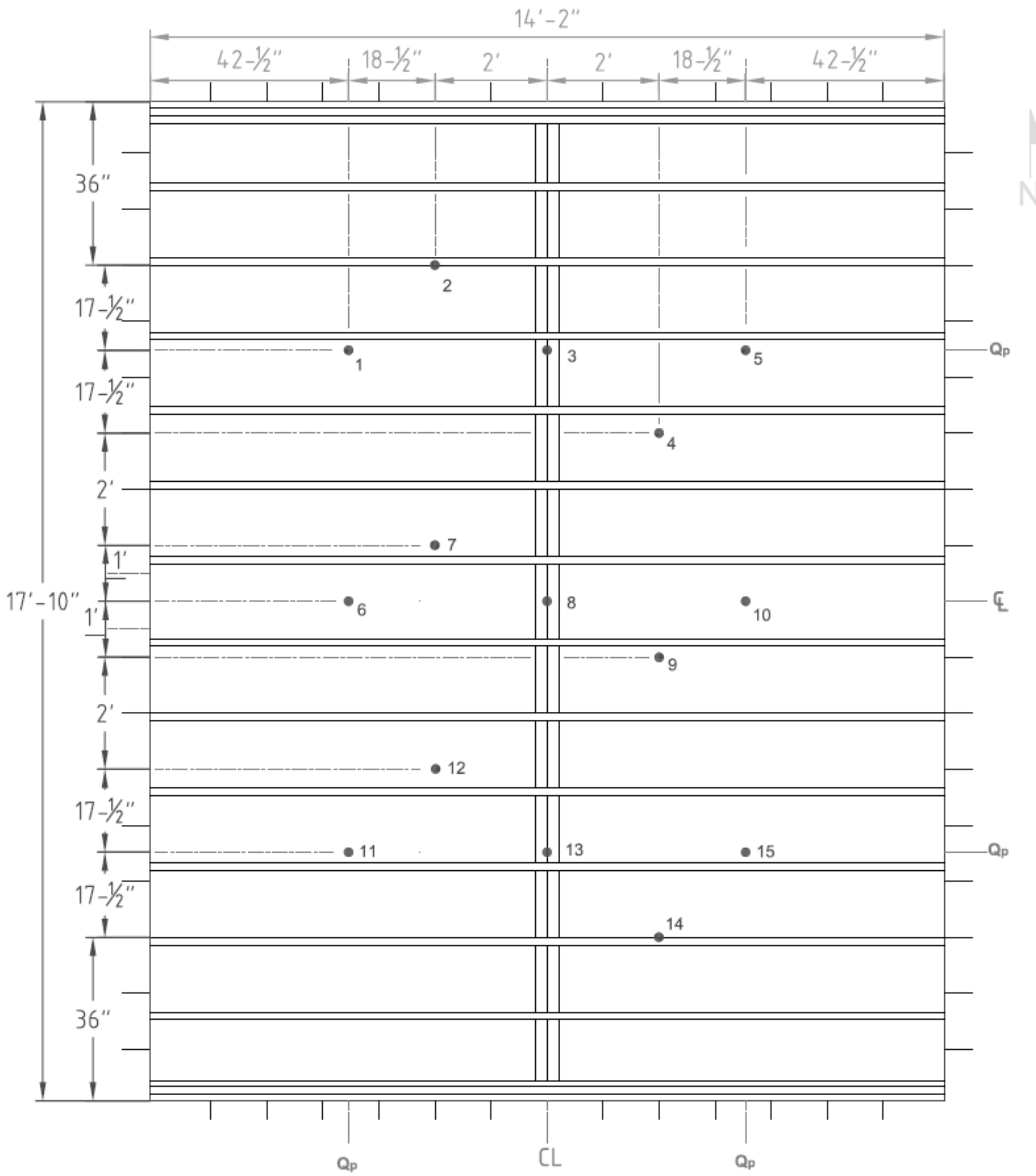


Figure A.8.5 – Thermocouple Locations on Subfloor.

Assembly No. 8

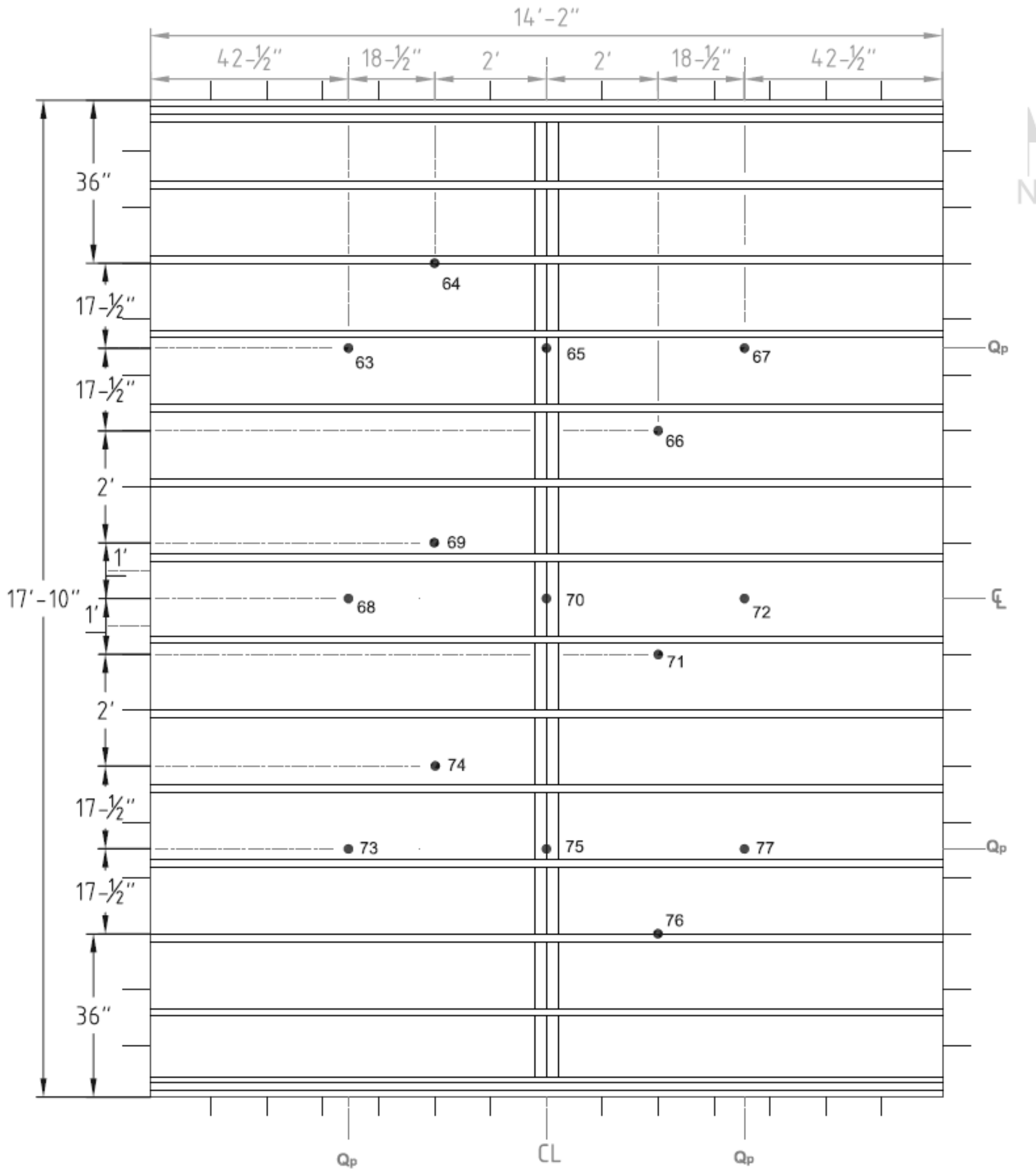


Figure A.8.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 8

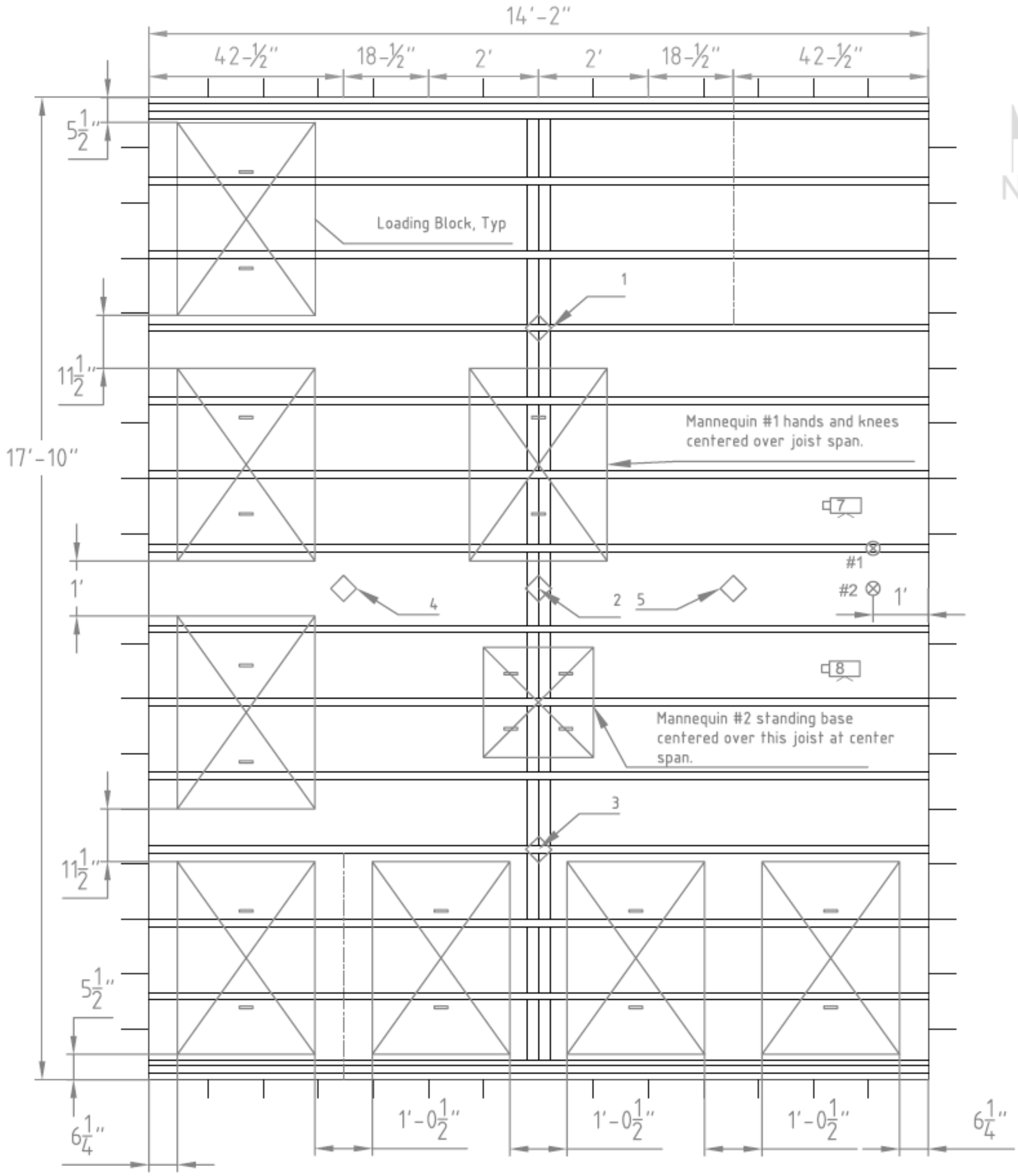


Figure A.8.7 – Loading and Instrumentation Layout (See Figure A.8.8).

Assembly No. 8

Deflection Transducers: ◇

1 - Along E-W Centerline, North Quarter-point.
2 - Along E-W Centerline, Center-point.
3 - Along E-W Centerline, South Quarter-point.
4 - Along N-S Centerline, East Quarter-point.
5 - Along N-S Centerline, West Quarter-point.

Accelerometers: ⊗

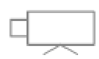
1- Over Joist, 12 in. from East edge of assembly.
2- Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 - Mannequin No. 1 (Hands & Knees)
2 - Mannequin No. 2 (Standing)

Video Camera Recordings: (Not Shown)

Channel 1409 - floor level view from northeast corner
Channel 1411 - IR camera from curing cell roof east center
Channel 1412 - furnace camera from northwest corner
Channel 1416 - overhead from east center of assembly
Channel 1413 - overhead from south center of assembly
Channel 1503 - overhead from west center of assembly

Video Camera Recordings: 

Channel 1415 - internal camera east (installed in joist cavity 6 from north facing west - under kneeling annequin #1.

Channel 1502 - internal camera east (installed in joist cavity 8 from north facing west -under standing mannequin #2.

Furnace Pressure Probes: (Not Shown)
1 - located near plate thermocouple No. 79

Oxygen Content : (Not Shown)
located in E exhaust duct.

Bi-directional Probe & 1.0 mm diameter thermocouple 80
80 - located near plate thermocuple No. 78. (Not shown)

Figure A.8.8 – Loading and Instrumentation Key

Assembly No. 9

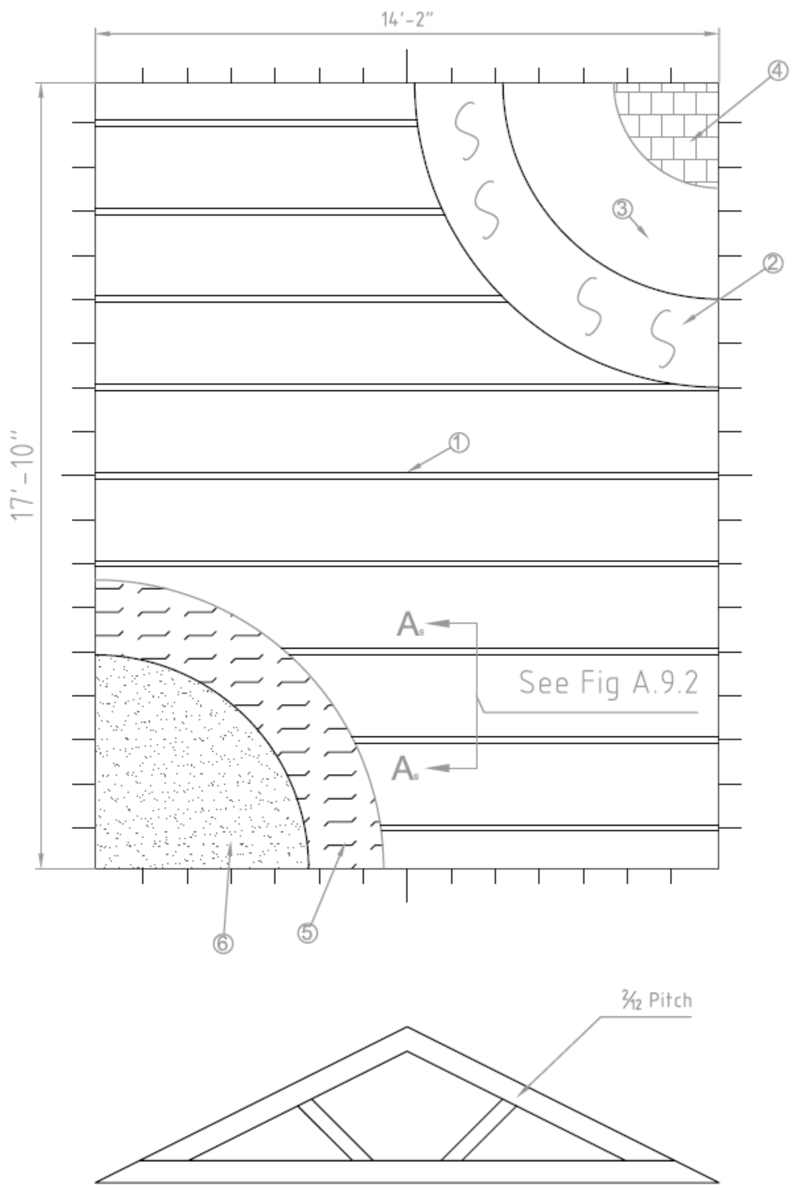


Figure A.9.1 – Construction Layout

Assembly No. 9

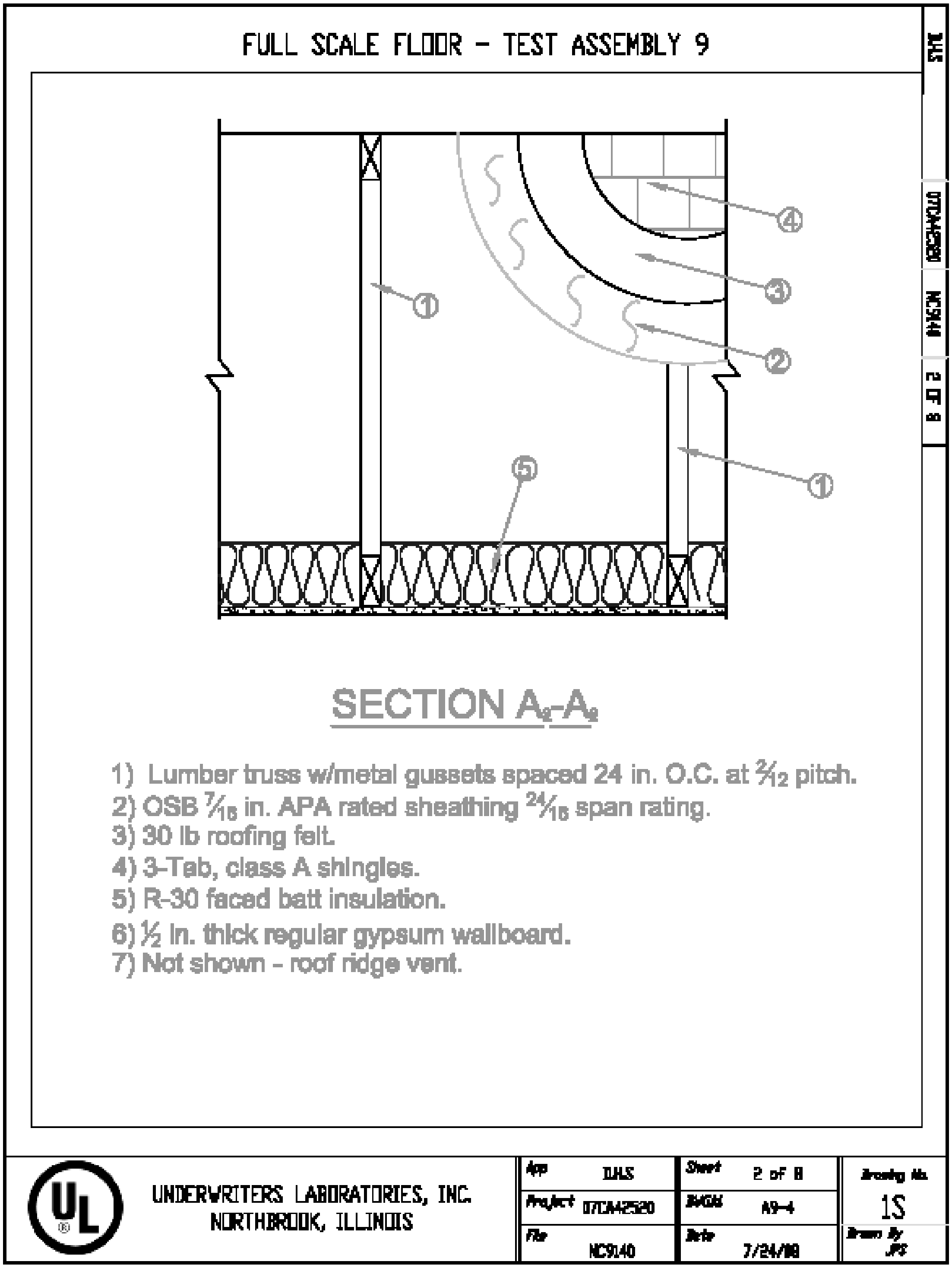


Figure A.9.2 – Construction Layout Section A_9-A_9.

Assembly No. 9

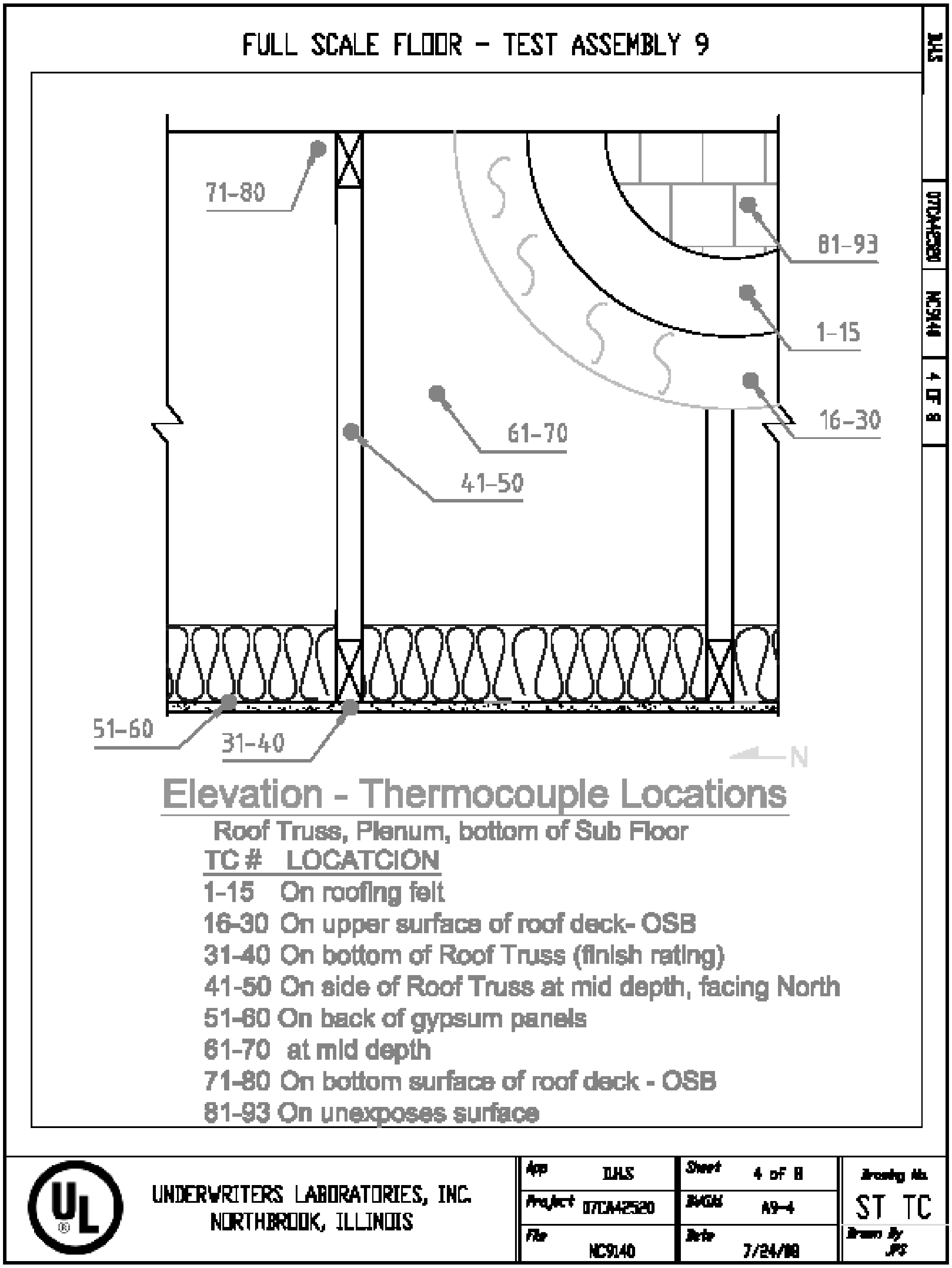


Figure A.9.3 – Thermocouple Locations - Elevation.

Assembly No. 9

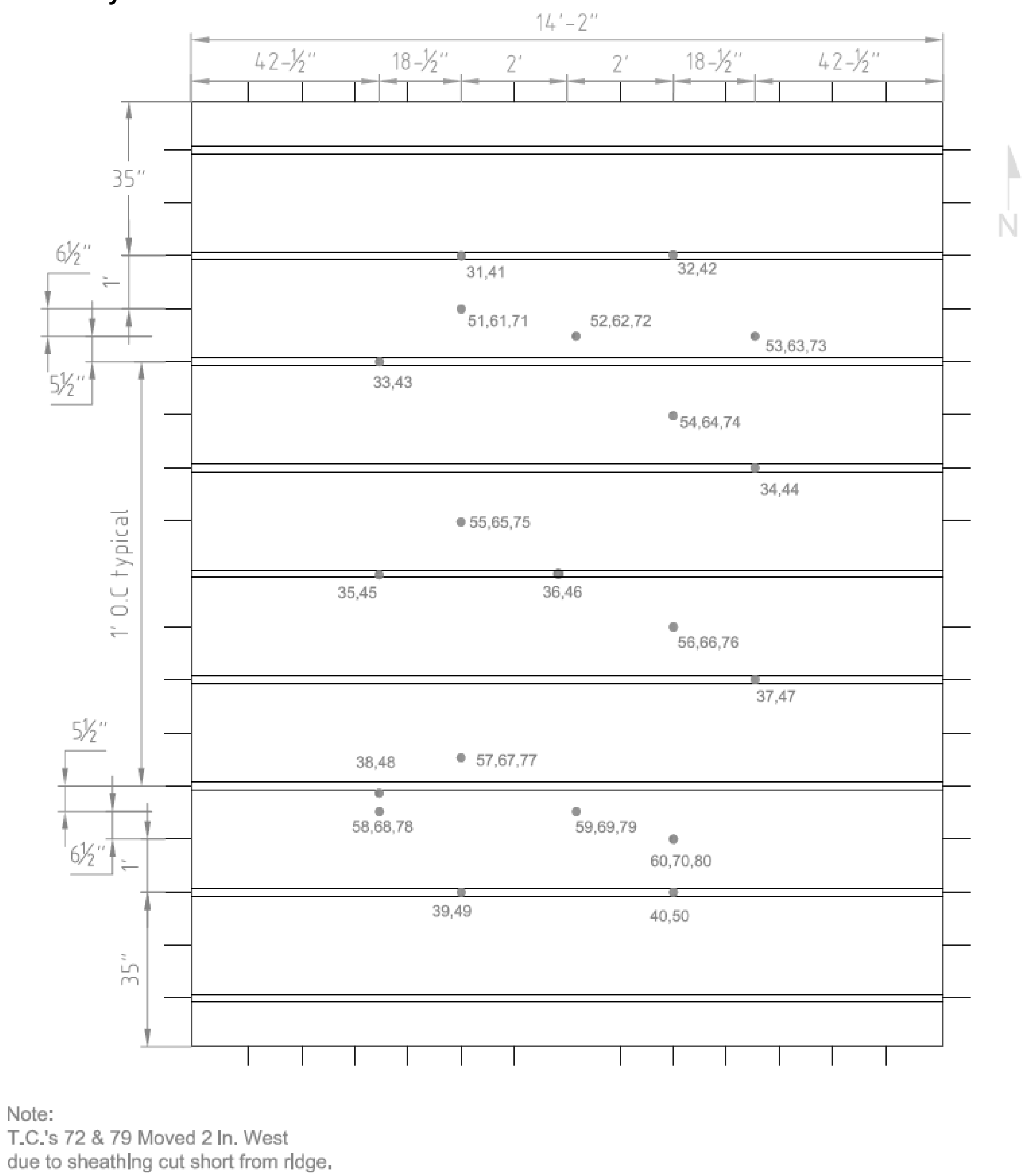
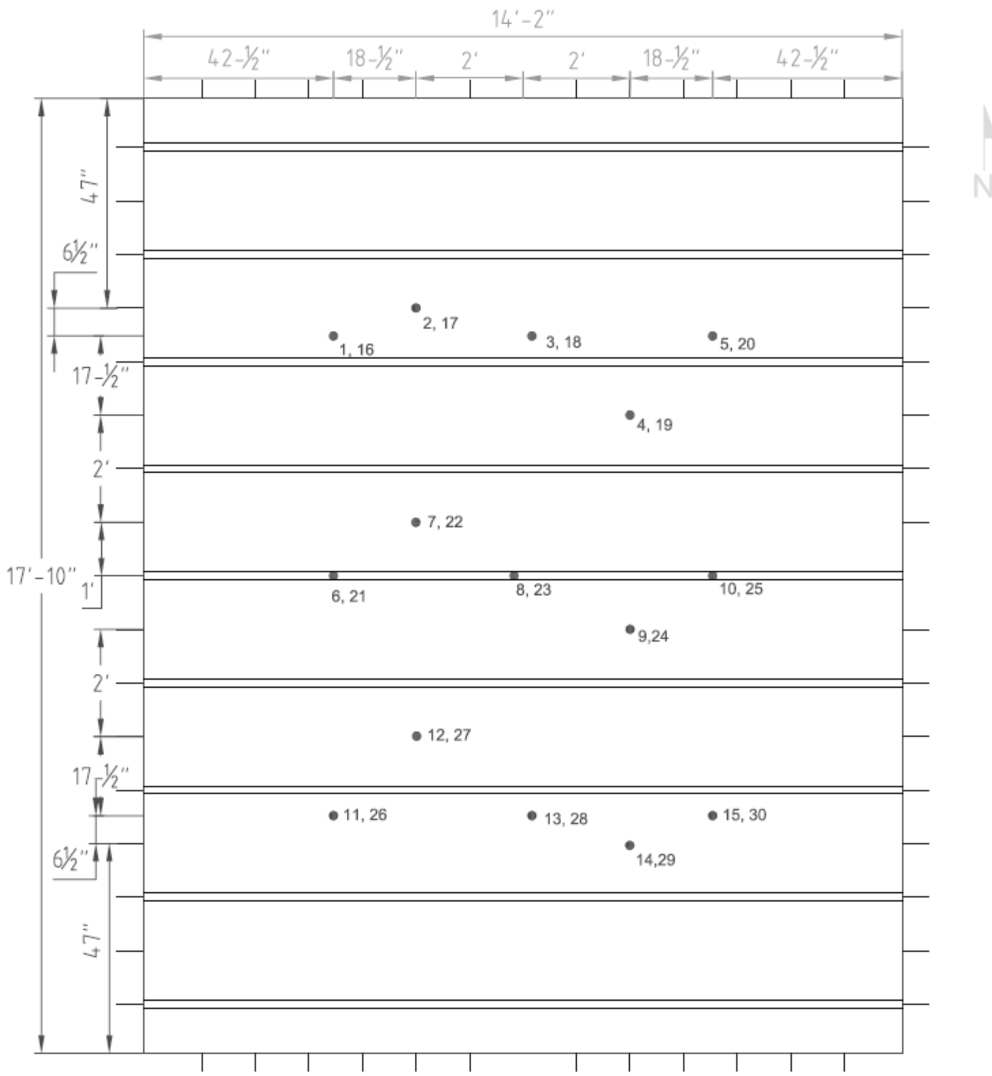


Figure A.9.4 – Thermocouple Locations on Wood Members.

Assembly No. 9



Note:
T.C.'s 3,13,18 & 28 moved 2 In. West.
T.C.'s 8,23 moved 2 in. East
Due to sheathing Being Cut short from ridge.

Figure A.9.5 – Thermocouple Locations on Roof Subfloor and Roof Felt.

Assembly No. 9

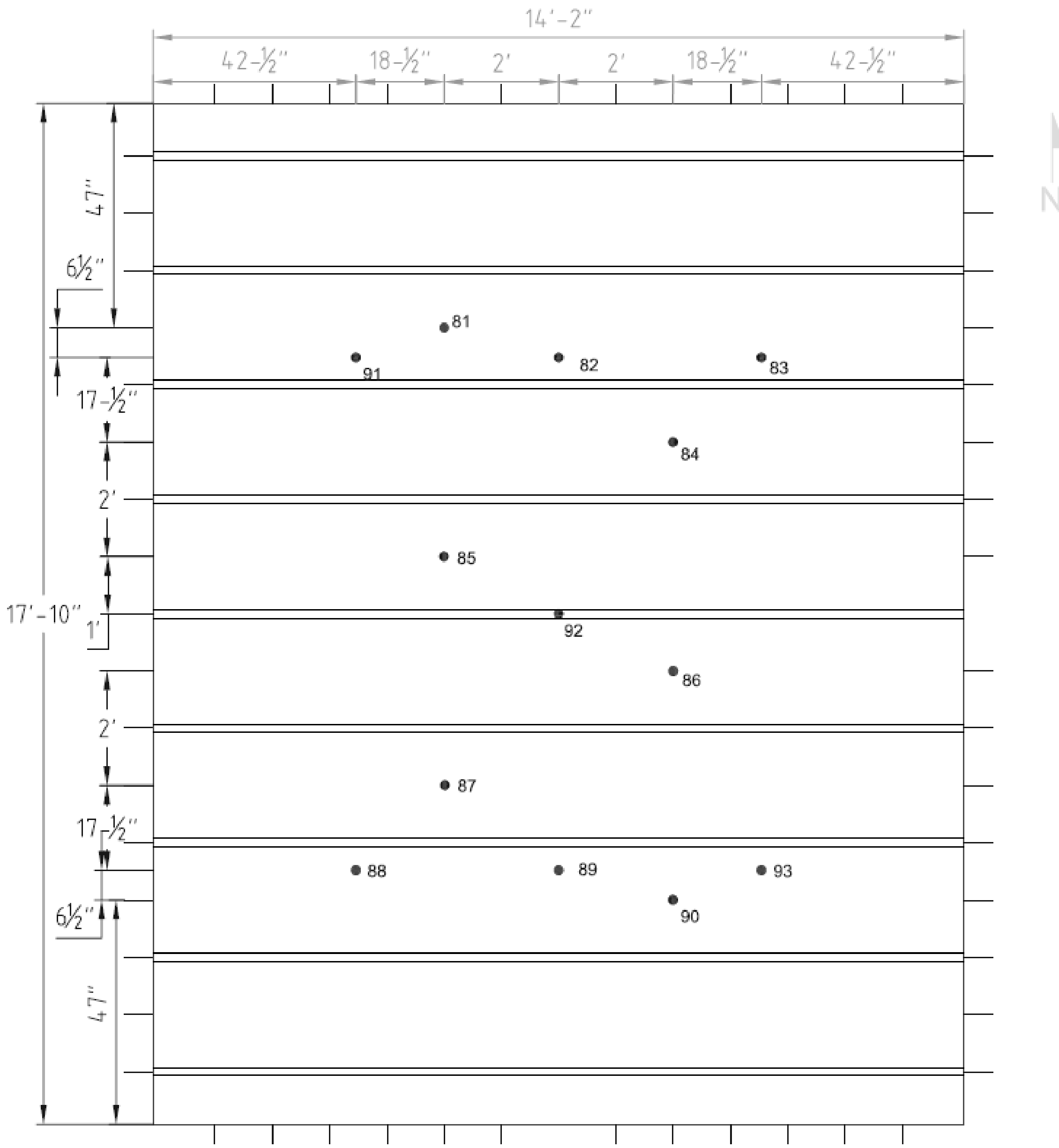


Figure A.9.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 9

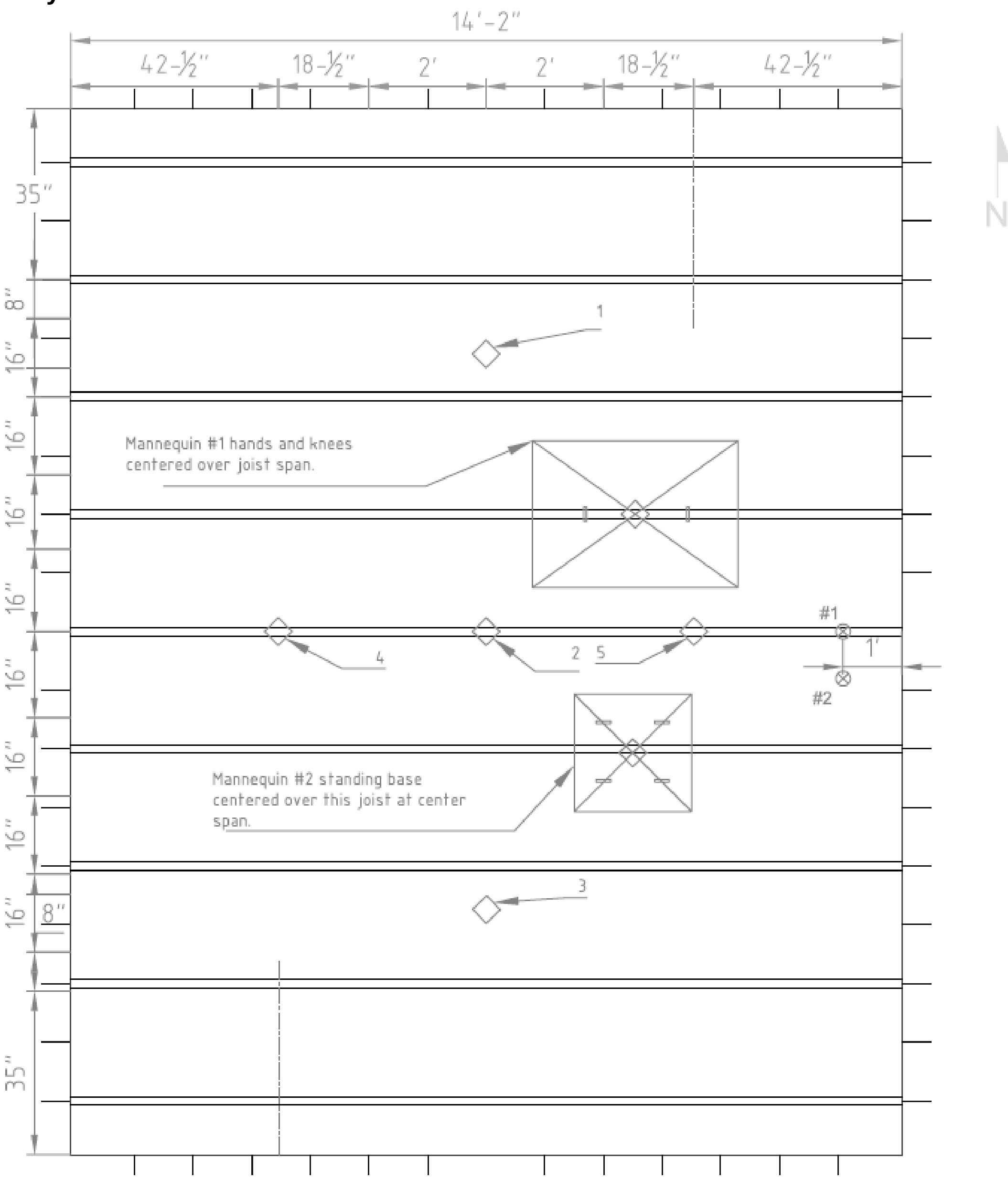


Figure A.9.7 – Loading and Instrumentation Layout (See Figure A.9.8).

Assembly No. 9

Deflection Transducers: ◇

1 - Along E-W Centerline, North Quarter-point.
2 - Along E-W Centerline, Center-point.
3 - Along E-W Centerline, South Quarter-point.
4 - Along N-S Centerline, East Quarter-point.
5 - Along N-S Centerline, West Quarter-point.

Accelerometers: ⊗

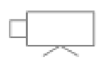
1- Over rafter, 12 in. from East edge of assembly.
2- Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 - Mannequin No. 1 (Hands & Knees)
2 - Mannequin No. 2 (Standing)

Video Camera Recordings:(Not Shown)

Channel 1409 - floor level view from northeast corner
Channel 1411 - IR camera from curing cell roof east center
Channel 1412 - furnace camera from northwest corner
Channel 1416 - overhead from east center of assembly
Channel 1413 - overhead from south center of assembly
Channel 1503 - overhead from west center of assembly

Video Camera Recordings: 

Channel 1415 - internal camera east (installed in joist cavity 6 from north facing west - under kneeling annequin #1.

Channel 1502 - internal camera east (installed in joist cavity 8 from north facing west -under standing mannequin #2.

Furnace Pressure Probes: (Not Shown)
1 - located near plate thermocouple No. 95

Oxygen Content : (Not Shown)
located in E exhaust duct.

Bi-directional Probe & 1.0 mm diameter thermocouple (Not Shown)
96- located near plate thermocouple No. 94

Figure A.9.8 – Loading and Instrumentation Key

the standard in safety

Underwriters Laboratories

Report
on
Structural Stability of Engineered Lumber in Fire Conditions

Project Number: 08CA33476
File Number: NC10412

Underwriters Laboratories Inc.
333 Pfingsten Road, Northbrook, IL 60062

Submitted to

Chicago Fire Department, City of Chicago
January 30, 2009

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Executive Summary

This report describes the fire resistive performance of three assemblies tested as part of a fire research and education program in cooperation with The City of Chicago Fire Department.

Introduction

This project was conducted by Underwriters Laboratories Inc (UL) to develop supplementary data on Structural Stability of Engineered Lumber in Fire Conditions in support of the DHS (Department of Homeland Security) sponsored research under the AFG (Assistance to Firefighter Grant) as detailed in the report dated September 30, 2008. In addition to the formal report, an internet based outreach to the fire service was developed and can be viewed at:

http://content.learnshare.com/courses/73/187716/player.html

The research resulted in identification of specific construction features not addressed by the original study. Thus, three additional assemblies, representing these construction features were tested to complement the original research.

Test Plan

A total of three fire tests were conducted on test assemblies representing floor–ceiling constructions so as to develop comparable fire performance data among assemblies. All the test assemblies were intended to represent typical residential construction.

The first assembly was constructed with parallel chord trusses with metal gusset connections as the structural components with a regular 1/2” gypsum board ceiling and included the following unique features:

- Recessed lighting fixture penetrations in the ceiling
- HVAC supply and return penetrations in the ceiling
- HVAC duct work in the interstitial space above the ceiling
- Metal gusset connection on the bottom cord
- AFG grant sponsored test # 5 was similarly constructed without the unique features noted above.

The second assembly was constructed with parallel chord truss with glued connections as the structural components. This assembly was similar to the AFG grant sponsored test # 6 with the exception that this test did not include a ceiling.

The third assembly was constructed with parallel chord truss with metal gusset connections as the structural components and included simulated stairwell framing.

The construction details of the three test assemblies are summarized in Table E-1 and detailed in Test Records 1 through 3.

Table E-1 - Summary of Test Samples

Test Assembly No.	Supports	Ceiling	Floor or Roof
1	Parallel chord truss with steel gusset plate connections, 14 inch deep @ 24 inch centers with bottom chord splices, can lights and duct work	1/2 inch regular gypsum wallboard	23/32 inch OSB subfloor, carpet padding & carpet
2	Parallel chord truss with glued connections, 14 inch deep @ 24 inch centers	None	23/32 inch OSB subfloor, carpet padding & carpet
3	Parallel chord truss with steel gusset plate connections, 14 inch deep @ 24 inch centers with simulated staircase and bottom chord splices	None	23/32 inch OSB subfloor, carpet padding & carpet

The three fire tests complied with the requirements of ASTM E119 but the applied structural load was non-traditional. Typically, a uniform load is applied on the floor to fully stress the supporting structural members. This load is generally higher than the minimum design load of 40 psf specified by the building code for residential construction. For the tests described in this report, the load placed on the samples was intended to represent typical conditions during a fire. A load of 40 psf was placed along two of the four edges of the floor – ceiling assemblies to represent loads around a perimeter of a room. On each sample, two 300 pound concentrated loads were placed near the center of the sample. A mannequin, intended to simulate fire service personnel, represented each concentrated load.

Standard ASTM E119, Fire Tests of Building and Construction Materials, describes a fire test method that establishes benchmark fire resistance performance between different types of building assemblies. For floor-ceiling assemblies, the standard requires a minimum 180 square foot sample prohibit the passage of flame through the sample and limit the temperature rise at specific locations as the sample while the sample supports a load and is exposed to a standardized fire. The standardized fire represents a fully developed fire within a residential or commercial structure with temperatures reaching 1000 ºF at 5 minutes and 1700 ºF at 60 minutes.

Test Results

The results of the ASTM E119 fire tests are expressed in terms of hours such as 1/2 hour, 1 hour or 2 hour rated assemblies. These time ratings are not intended to convey the actual time a specific structure will withstand an actual fire event due to differences in building configuration and construction, fuel load, and ventilation. However, the results from ASTM E119 test method enable a useful benchmark to compare the fire resistance performance of test assemblies.

For unrestrained floor-ceiling assemblies such as the tested assemblies, ASTM E119 includes the following Conditions of Acceptance:

1. The sample shall support the applied load without developing conditions that would result in flaming of cotton waste place on the floor surface.
2. Any temperature measured on the surface of the floor shall not increase more than 325 ºF and the average temperature measured on the surface of the floor shall not increase more than 250 °F.

The results of the three fire tests in terms of the ASTM E119 Conditions of Acceptance are summarized in Table E-2.

Table E-2 - Summary of Test Results ASTM E119

Test Assembly No.	Time of 250ºF avg. temperature rise on surface of floor (min:sec)	Time of 325ºF max. temperature rise on surface of floor (min:sec)	Flame passage through floor (min:sec)	Collapse (min:sec)	Fire resistance rating (min)
1	*	*	26:00	30:08	26
2	12:30	11:15	11:45	13:06	11
3	10:45	5:00	11:30	13:20	5

Notes:
* - This condition was not achieved during the fire test.

In addition to the fire resistance rating determined by the Conditions of Acceptance in ASTM E119, a finish rating is typically published for fire resistive assemblies with combustible supports such as the tested samples. The finished rating is defined as the time when the first occurrence of either:

1. Temperature measured on the face of the combustible supports nearest to the fire increases more than 325 ºF; or
2. Average temperature measured on the face of the combustible supports nearest the fire increases more than 250 ºF.

Several fire test standards similar to ASTM E119 such as ISO 834:1 (Fire-resistance tests – Elements of building construction – Part 1: General requirements) define load bearing capacity as the elapsed time that a test sample is able to maintain its ability to support the applied load during the fire test. The ability to support the applied load is determined when both:

1. Deflection exceeds: $\frac{L^2}{400d}$; and
2. When the deflection exceeds $\frac{L}{30}$, the Rate of Deflection exceeds: $\frac{L^2}{9000d}$
   where L is the clear span measured in millimeters and d is the distance from the extreme fiber of the design compression zone to the extreme fiber of the design tensile zone of the structural element as measured in millimeters.

Other significant data obtained during the fire tests included observation of the conditions of the ceiling and floor surfaces, temperatures in the concealed space above the ceiling membrane and deflections of the floor and roof surfaces.

The finish rating and the load bearing capacity of Benchmark assemblies from the AFG sponsored project and the three tested assemblies are summarized in Table E-3

Table E-3 - Summary of Significant Events in Addition to ASTM E119 Conditions of Acceptance

Test Assembly No.	Initial falling of ceiling material (More than 1 ft^2) (min:sec)	Average temperature on unexposed surface of ceiling at initial falling (°F)	Finish rating (min:sec)	Load bearing Capacity (min)
Benchmark1 [1]	No ceiling	No Ceiling	00:45	18
Benchmark2 [2]	16:00	559	12:15	25
Benchmark3 [3]	16:30	519	10:45	24
Benchmark4 [4]	23:30	605	15:30	45
Benchmark5 [5]	74:00**	1109	74:00**	80
1	17:15	646	13:00	24
2	No ceiling	No ceiling	00:15	10
3	No ceiling	No ceiling	00:30	5

** - plaster ceiling in contact with furnace thermocouples at 51 minutes

Notes:

1 – Benchmark 1 data represents a combustible floor-ceiling assembly of typical unprotected legacy construction (2 x 10) without a ceiling

2 – Benchmark 2 data represents a combustible floor-ceiling assembly of typical modern construction of parallel chord truss with glued connections with a ½ thick regular gypsum board ceiling

3 – Benchmark 3 data represents a combustible floor-ceiling assembly of typical modern construction of parallel chord truss with steel gusset connections with a ½ thick regular gypsum board ceiling
4 – Benchmark 4 data represents a combustible floor-ceiling assembly of typical protected legacy construction (2 x 10) with a ½ inch regular gypsum board ceiling
5 – Benchmark 5 data represents a combustible floor-ceiling assembly of typical protected legacy construction (2 x 10) with a ¾ inch metal lath and plaster ceiling

Research Findings

The following summarizes the key findings documented in this report:

From the previous AFG sponsored project, it was determined that the fire containment performance (load bearing capacity) of a combustible floor-ceiling assembly representing typical unprotected legacy construction (2 x 10) without a ceiling was 18 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This was defined as the benchmark (Benchmark 1) fire resistance performance of traditional exposed lumber construction typically found in lowest floor above basement or crawl spaces.

- The fire containment performance of Test Assembly 1 representing modern steel gusset truss construction with a ceiling with penetrations was 6 minutes more than the benchmark performance.
- The fire containment performance of Assembly 2 representing unprotected modern glued truss construction was 8 minutes less than the benchmark performance.
- The fire containment performance of Assembly 3 representing unprotected modern steel gusset construction with stairwell framing was 13 minutes less than the benchmark performance.

From the previous AFG sponsored project, it was determined that the fire containment performance (load bearing capacity) of a combustible floor-ceiling assembly representing typical modern construction of parallel chord truss with glued connections with a ½ thick regular gypsum board ceiling was 25 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This was defined as the benchmark (Benchmark 2) performance of modern glued joint truss construction with a regular gypsum board ceiling typically found in floors above living spaces.

- The fire containment performance of Assembly 2 without the ceiling was 15 minutes less than the benchmark performance.

From the previous AFG sponsored project, it was determined that the fire containment performance (load bearing capacity) of a combustible floor-ceiling assembly representing typical modern construction of parallel chord truss with steel gusset connections with a ½ thick regular gypsum board ceiling was 24 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in

Standard ASTM E119. This was defined as the benchmark (Benchmark 3) performance of modern metal gusset truss construction with a regular gypsum board ceiling typically found in floors above living spaces.

- The fire containment performance of Assembly 3 without the ceiling and framed with a stairwell opening was 19 minutes less than the benchmark performance.

From the previous AFG sponsored project, it was determined that the fire containment performance (load bearing capacity) of a combustible floor-ceiling assembly representing typical protected legacy construction (2 x 10) with a ½ inch regular gypsum board ceiling was 45 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This was defined as the benchmark (Benchmark 4) performance of traditional lumber construction with a regular gypsum board ceiling typically found in floors above living spaces.

- The fire containment performance of Assembly 1 was 21 minutes less than the benchmark performance.
- The fire containment performance of Assembly 2 was 35 minutes less than the benchmark performance.
- The fire containment performance of Assembly 3 was 40 minutes less than the benchmark performance.

From the previous AFG sponsored project, it was determined that the fire containment performance (load bearing capacity) of a combustible floor-ceiling assembly representing typical protected legacy construction (2 x 10) with a ¾ inch metal lath and plaster ceiling was 80 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This was defined as the benchmark (Benchmark 5) performance of traditional lumber construction with a metal lath and plaster ceiling typically found in floors above living spaces.

- The fire containment performance of Assembly 1 was 56 minutes less than the benchmark performance.
- The fire containment performance of Assembly 2 was 70 minutes less than the benchmark performance.
- The fire containment performance of Assembly 3 was 75 minutes less than the benchmark performance.

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General

This section describes the construction of the test assemblies, and the test results.

Test Assembly Materials

Several materials were used to construct more than one test assembly. The assemblies in which these materials were used are identified in Table 1.

Table 1 - Identification of Materials used in Multiple Assemblies

Material	Assembly Number		
	1	**2**	**3**
Bearing Plates - 2 by 6	Yes	Yes	Yes
Subflooring (OSB)	Yes	Yes	Yes
Carpet with Padding	Yes	Yes	Yes
Tack Strip	Yes	Yes	Yes
Gypsum Board - 1/2 in.	Yes	No	No

The materials used in more than one assembly are described below.

Bearing Plate (2 by 6) – The nominal 2 in. by 6 in. dimensional lumber measured 1-1/2 in. by 5-1/2 in.

Subflooring (OSB) – Nominal 96 in. by 48 in. by 3/4 in. thick tongue and groove subflooring.

Carpet Padding – The carpet padding measured 5/16 in. thick and was supplied in 6 ft wide by 45 ft long rolls. The carpet padding weighed 0.20 lbs/ft^2.

Carpet – The carpet was supplied in a 14 ft 2 in. wide by 18 ft. long roll. The nominal thickness of the carpet was 1/2 in. The carpet contained no identification markings. The carpet weighed 0.39 lbs/ft^2.

Tack Strip – Premium carpet gripper measured 1/4 in. thick by 7/8 in. wide and 48 in. long. The pre-nailed tack lengths were 3/4 in. and were spaced approximately 5-3/4 in. apart along the strip.

Gypsum Board – The nominal 1/2 in. thick regular gypsum wallboard had tapered edges and measured an average of 8 ft long by 4 ft wide and had an average thickness of 1/2 in.

Fire Endurance Test

The fire tests were conducted in accordance with the Standard, Fire Tests of Building Construction and Materials, ASTM E119 (ANSI/UL 263, 13th Edition, April 4, 2003).

Test Assemblies, Structural Load, and Instrumentation

The standard test equipment of (UL) for floor and ceiling assemblies was used for the fire endurance test. The test assemblies were constructed by UL staff at UL's fire test laboratory located in Northbrook, IL.

During preparation of the test frames by UL prior to the construction of the test assembly, 4 in. by 6 in. by 3/4 in. thick steel angles were secured to the East and West edges of the test frames and set at depths of 17 in. for each of the three assemblies. The test frame was protected with vermiculite concrete poured to the top of the angles.

Assemblies 1-3 were loaded with 40 psf applied to the South and West edges of the assembly. The assembly was divided into quarters in the length and width. The loading was positioned over the Western and Southern quarters of the assembly. In addition to the uniform load, two 300 lb mannequins were located 24 inches North and South of the East-West centerline of the assembly, at the center of the span. One mannequin was intended to simulate a standing firefighter and the load was distributed over a four square foot base. The other mannequin was intended to simulate a crawling firefighter and the load was distributed through the hands and knees. Drawings showing the floor assembly loading are located in Appendix A.

The location of instrumentation within the furnace and on the test samples is shown in Appendix A. The furnace chamber temperatures were measured with 16 thermocouples located 12 in. below the exposed surface. A plot of the average furnace temperature verses the standard time temperature curve can be seen under the results portion of each test record.

Pre-Test Measurements

Test Method

All three assemblies were tested in accordance with the fire exposure in ASTM E119 (ANSI/UL 263, 13th Edition, April 4, 2003).

Fire Performance Criteria

The condition of acceptance for these standards state the transmission of heat thought the specimen during the classification period shall not have raised the average temperature on its unexposed surface to more than 250°F above its initial temperature or the individual temperature at any point to more than 325°F above its initial temperature. The specimen shall have sustained the applied load during the classification period without developing unexposed surface conditions that will ignite cotton waste.

The deflection of each assembly after application of the load is shown below in Table 2.

Table 2 - Deflection of Assembly After Application of Load

Test Assembly Number	Max. Deflection (Inch)
1	0.17
2	0.05
3	0.06

The floor ceiling assemblies were installed in the test frame in accordance with standard practices and methods. The test assemblies were constructed by UL staff at UL's fire test laboratory located in Northbrook, IL.

Test Record No. 1

Materials

Materials described in section General and used in Assembly No. 1 include 2 by 6 bearing plates, subfloor (OSB), carpet and padding, tack strips, and gypsum board. Additional materials are described below.

Trusses - The parallel chord trusses with trimable ends were 14 in. deep, 13 ft 10 in. long fabricated from nominal 2 in. by 4 in. wood members and had an average weight of 56.01 lb. The nominal 4 in. side of the truss members was oriented in the horizontal direction. The truss members were secured together with galvanized steel plates measuring 0.038 in. thick. The plates contained teeth projecting perpendicular to the plane of the plate. The bottom chord of the trusses were spliced and secured together using a 3 in. by 6 in. steel plates. The splice was located 77 in. from the east edge of the assembly. The moisture content of the truss members ranged from 10.9 to 13.2 percent and averaged 12.09 percent.

Rim Band – The nominal 2 in. by 4 in. dimensional lumber measured 1-1/2 in. by 3-1/2 in.

Strongback – The nominal 2 in. by 6 in. dimensional lumber measured 1-1/2 in. by 5-1/2 in.

Blocking – Nominal 2 in. by 2 in. dimensional lumber was used to mount the diffuser.

Can Light Fixture – The steel can light base measured 9-3/4 in. by 7-1/2 in. and 6-1/2 in. deep with an aperture opening of 6-1/2 in. in diameter. The can light fixtures contained two steel mounting brackets which could be extended to 23-3/4 in.

Can Light Fixture Insert – The plastic and steel fixture insert measured 4-3/8 in. in diameter at the top and 6-1/8 in. at the opening. The steel plate at the bottom of the insert measured 7-1/8 in. in diameter. The insert had an overall depth of 2-3/4 in. as was attached to the can light fixture using two metal springs.

Rigid Duct Reducer – The metal rigid duct reducer measured 10 in. in diameter at the bottom, 6 in. in diameter at the top and had an overall height of 8 in.

Diffuser – The metal diffuser measured 5-3/8 in. wide by 11-3/8 in. long with vents centered and measuring 3-3/4 in wide by 9-1/2 in. long. The diffuser was secured to the 2 in. by 2 in. blocking using two 2 in. long hex-head screws.

Rigid Duct – The metal rigid duct measured 10 in. in diameter and 14 ft 7 in. long.

Flexible Duct – The UL Listed Class 1 Flexible Air Duct measured 6 in. in diameter.

Register Air Supply Duct Sleeve – The metal sleeve measured 6 in. in diameter at the top and reduced to a 4 in. by 10 in. rectangular opening.

Erection of Test Assembly

Nominal 2 in. by 6 in. structural grade wood bearing plates were placed on top of the steel angles. The trusses were placed on the wood bearing plates and spaced 24 in. OC starting at the East West centerline of the assembly. At the North and South ends of the assembly, additional trusses, not in the field of the fire test, were placed over the vermiculite concrete in order stabilize the plywood subfloor. The trusses were fastened to each bearing plate with two No. 16d nails.

Nominal 2 in. by 6 in. structural grade strongbacks were run perpendicular to the vertical member of the trusses located 5 ft 7-7/8 in. from the West side of the assembly. The strongback was secured to the vertical wood members of the trusses with two No. 16d nails at each strongback / truss interface.

Along the east and west edges of the test assembly, nominal 2 in. by 4 in. wood headers (rim band) were placed perpendicular to the trusses and fastened to the top chord of each truss with two No. 16d nails.

A 1/4 in. wide bead of adhesive was placed on the top chord of the trusses. The plywood subfloor was placed on the trusses with the 8 ft long edges positioned perpendicular to the trusses and the ends butted and centered over trusses, with adjacent end joints staggered 4 ft. A 1/8 in. wide bead of adhesive was placed on the tip of the tongue and groove ends of the subfloor before sliding the panels together. The plywood was secured to the trusses with 1-7/8 in. long ringshank underlayment nails spaced 6 in. OC at the perimeter and 12 in. OC in the field with nails 1 in. from the edge of each panel.

The pre-nailed tack strips were secured to the subfloor around the perimeter of the assembly approximately 2 in. from the inside edge of the test frame.

The 6 ft wide carpet padding had joints spaced 6 ft,12 ft and 17 ft 2 in. starting at the South edge of the assembly. The carpet padding was secured to the subfloor with 1/4 in. long staples spaced 18 in. OC around the perimeter of each laid piece of padding.

The 14 ft 2 in. wide by 17 ft 10 in. long roll of carpet was laid on top of the carpet padding. The carpet was stretched tight and secured to the carpet gripper nailing strips located at the perimeter of the entire assembly.

Six can lights were installed in accordance with the manufacturers installation instructions and located 36 in. from the East and West edges of the assembly. Two of the can lights were located 4 in. South of the centerline truss. Two of the can lights were located 10-1/4 in. South of the third truss on the North side of the assembly. The last two can lights were located 10-1/4 in. North of the third truss on the South side of the assembly.

The 10 in. diameter rigid duct was capped on both ends. The South end of the duct was wrapped with a 12 in. diameter piece of ceramic fiber blanket and butted tight against the South test frame wall. The duct was installed in the boxed portion of the truss located 6 in. East of the North/South centerline. The rigid duct was supported using three galvanized steel straps located approximately 6 ft on center and were secured to the top chord of the trusses with one 8d nail at each end. The rigid duct was suspended 3/4 in. above the bottom chords of the trusses. The joints connecting the rigid duct sections to the duct tees were secured with six 1/2 in. wafer head screws. All joints were taped with aluminum tape.

The large end of the rigid duct reducer was attached to the 10 in. diameter rigid duct tee with six 1/2 in. wafer head screws and UL Listed aluminum tape.

The 48 in. and 36 in. long sections of flexible duct were loose laid in the joist cavities. One end was attached to the rigid duct reducer and the other end was secured to the register air supply duct sleeve using UL Listed aluminum tape. The register air supply duct sleeve was secured to 2 in. by 2in. wood blocking. The registers were located approximately 3 ft on either side of the centerline truss. One register was located 48 in. West of the rigid duct and the second register was located 36 in. East of the rigid duct.

The gypsum board was secured to the exposed side of the assembly with 1-5/8 in. long phosphate coated drywall nails spaced 7 in. OC with the first two nails spaced 1 in. and 6-1/2 in. from the edge. The East-West gypsum board joints were staggered 48 in. The North-South gypsum board joints were aligned. The long edges of the boards were oriented perpendicular to the joists. Two layers of dry mix joint compound was used to cover all gypsum board joints and nails heads.

Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The location of instrumentation within the furnace and on the test sample are shown in Appendix A.

The temperatures of the wood trusses were measured with 20 thermocouples numbered 31-40 were located on the bottom of the trusses and thermocouple numbers 41-50 were located on the side of trusses mid depth facing North and stapled to the trusses.

The temperatures within the interstitial space were measured with 26 thermocouples. These thermocouples were numbered 61-70 and located at mid depth. Thermocouple numbers 71-80 were located on the bottom of the subfloor. Thermocouples numbered 81-83 were located on the top metal gusset plates nearest center of assembly facing North. Thermocouples numbered 84-86 were located on the bottom metal gusset plates nearest center of assembly facing North.

The temperatures between the subfloor and carpet padding were measured with 15 thermocouples and numbered 1-15.

The temperatures on top of the carpet padding (between the carpet padding and carpet) were measured with 15 thermocouples and numbered 16-30.

The unexposed surface temperatures were measured with 13 thermocouples and numbered 87-99. Each thermocouple was covered with a 6 by 6 in. dry ceramic fiber pad.

The temperatures on the unexposed side of the gypsum board were measured with 10 thermocouples and numbered 51-60.

The temperatures on top of the can lights were measured with one thermocouple over each of the 6 can lights and numbered 102-107.

The temperatures on top of the flexible ducts right before the junctions of supply register inlets was measured with two thermocouples numbered 108 and 109.

The temperatures on top of the flexible ducts at mid span were measured with two thermocouples numbered 110 and 111.

The temperatures on top of the rigid supply duct were measured with two thermocouples numbered 112 and 113.

The deflection of the assembly was measured with five electronic transducers.

There were a total of ten camera views taken during the fire exposure period. One camera was positioned in the furnace recording the exposed surface of the assembly, four cameras positioned in the interstitial space between the gypsum board and sub floor. Four other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 1.

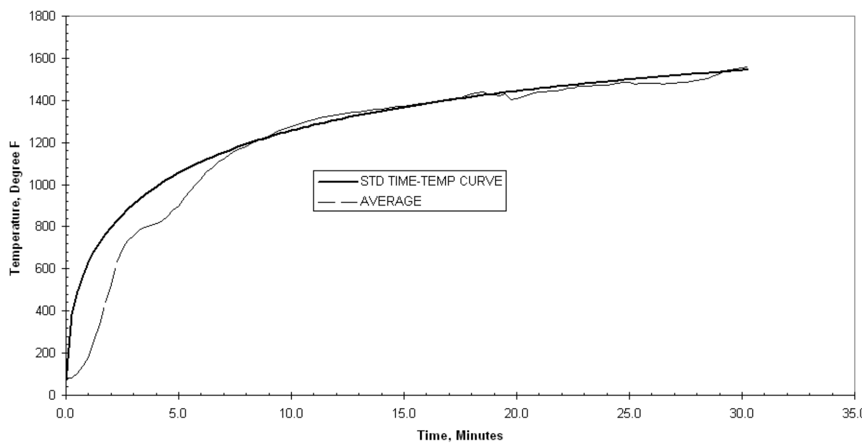


Figure 1 - UL263 (E119) Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Assembly No. 1

The furnace pressure and oxygen concentration during the test are presented in Figure 2 and Figure 3.

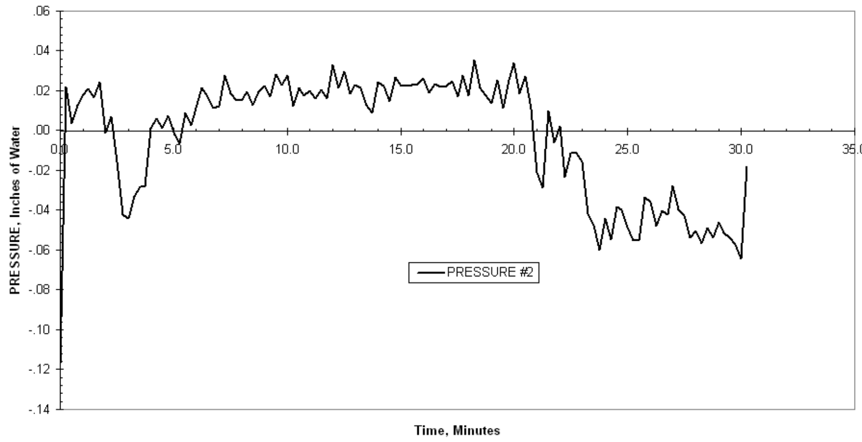


Figure 2 - Furnace Pressure vs. Time for Assembly No. 1

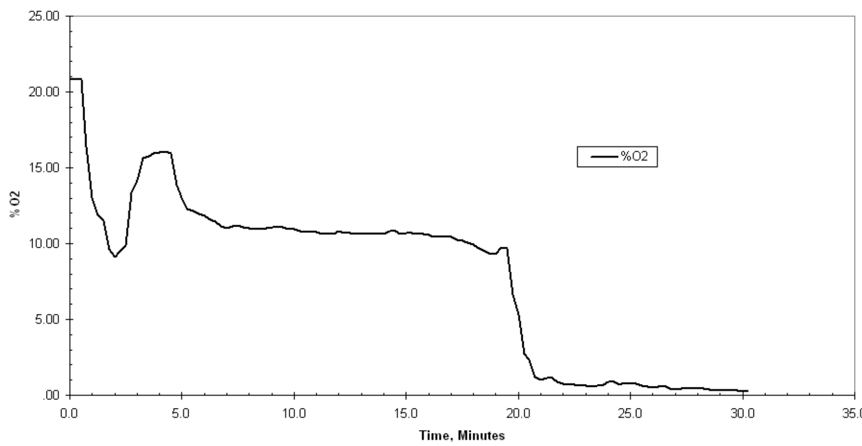


Figure 3 - Oxygen Content vs. Time for Assembly No. 1

Observations of the Exposed and Unexposed Surfaces - The observations made during the fire test are presented in Table 3. All references to dimensions are approximate.

Table 3 – Observations for Assembly No. 1

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
00:45	E	The paper surface ignited.
01:15	E	The can lights were flaming.
04:00	U	No changes noted.
04:30	E	The paper surface was charred and flaking.
04:45	E	The joint compound began to fall. The trim rings of the can lights were hanging.
05:00	E	The trim rings on the east can lights fell into the furnace chamber.
05:30	E	The registers were becoming deformed.
06:00	U	Smoke issued from the perimeter of the assembly.
07:00	E	The joint compound continued to fall.
09:45	E	The joint compound continued to fall.
10:15	E	Additional trim rings fell into the furnace chamber.
14:00	E	90% of the joint compound had fallen.
15:15	E	Cracks in the gypsum board were noted near the center can lights.
16:00	E	The north-east register fell into the furnace chamber. Cracks in the gypsum board were noted near the south can lights.
17:15	E	Pieces of gypsum boards fell into the furnace chamber.
18:00	U	No changes besides smoke at the perimeter of the assembly.
18:15	E	20 to 25% of the gypsum boards had fallen.
18:45	U	Cracking noises heard.
18:45	E	Cracking noises heard.
19:30	U	Cracking noises continued. Smoke continued.
20:00	E	Visual observations could not be taken due to heavy flaming.
20:15	E	90% of the gypsum boards had fallen.
21:00	U	Very little deflection noted.
22:45	U	Bulges in the carpet noted at the subfloor joints.
24:00	U	Smoke began to emit from the carpet.
25:00	U	Vibration of the firefighters noted.
26:00	U	Flame through on south edge.
27:15	U	Flame through on north edge.
29:00	U	The carpet was buckled over the entire assembly.
29:45	U	A significant drop of the floor was noted.
30:08	E/U	Structural collapse occurred. Furnace fire extinguished.

Temperatures of the Trusses - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom chords nearest the fire 250°F or the time required to raise the temperature on the bottom chords 325°F at any point. The average temperature measured on the bottom chords of the trusses was 78°F before the test. Therefore, the average limiting temperature was 328°F and the individual limiting temperature was 403°F.

The maximum individual limiting temperature for the finish rating was reached at 13 minutes as recorded by thermocouple number 40. A plot of the finish rating temperatures can be seen in Appendix A.

Temperatures at Mid Depth on the Side the Wood Trusses – The average and maximum temperatures of the sides of the wood trusses just before the moment of collapse (30 min 8 sec) were 1446°F and 1490°F respectively. The individual temperature was recorded by thermocouple number 41. A plot of these temperatures can be seen Figure 4.

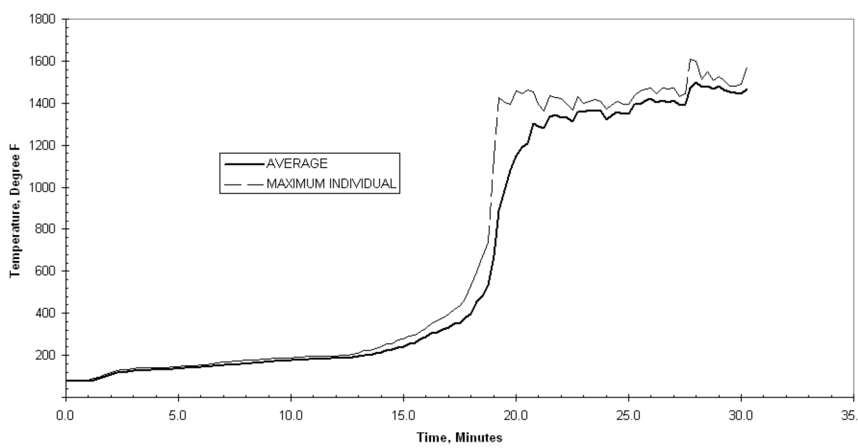


Figure 4 - Plot of Temperature of the Average and Maximum Individual Side Of Wood Trusses vs. Time for Assembly No. 1

Temperatures of the Mid Depth Between Wood Trusses – The average and maximum temperatures of the mid depth between the wood trusses just before the moment of collapse (30 min 8 sec) were 1423°F and 1445°F respectively. The individual temperature was recorded by thermocouple number 64. A plot of these temperatures can be seen on Figure 5.

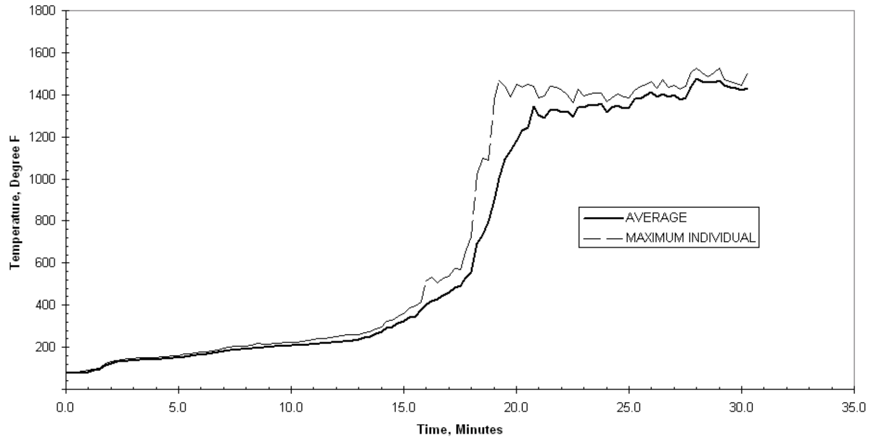


Figure 5 - Plot of Temperature of the Mid Depth Between Wood Trusses vs. Time for Assembly No. 1

Temperatures of the Sub Floor Between Wood Trusses – The average and maximum temperatures of the sub floor between the wood trusses just before the moment of collapse (30 min 8 sec) were 1432°F and 1464°F respectively. The individual temperature was recorded by thermocouple number 74. A plot of these temperatures can be seen on Figure 6.

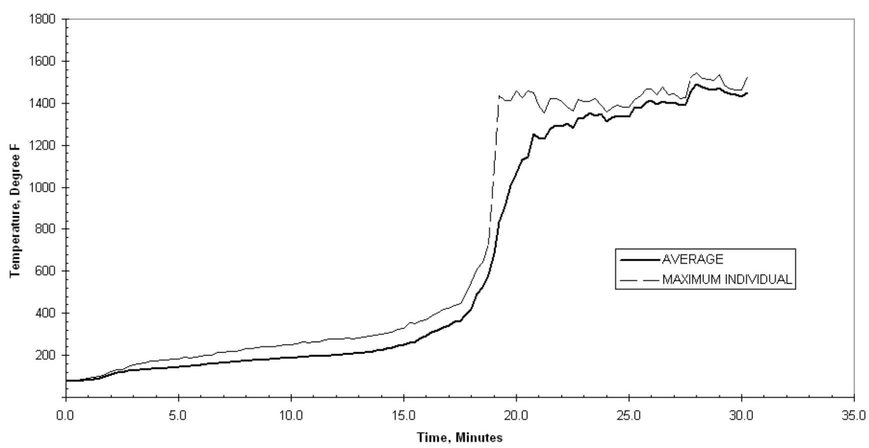


Figure 6 - Plot of Temperature of the Sub Floor Between Wood Trusses vs. Time for Assembly No. 1

Temperatures of the Metal Gusset Plates – The average and maximum temperatures of the bottom metal gusset plates just before the moment of collapse (30 min 8 sec) were 1416°F and 1434°F respectively. The individual temperature was recorded by thermocouple number 83. The average and maximum temperatures of the top metal gusset plates just before the moment of collapse (30 min 8 sec) were 1434°F and 1459°F respectively. The individual temperature was recorded by thermocouple number 86. A plot of the metal gusset temperatures can be seen on Figure 7 and 8 respectively.

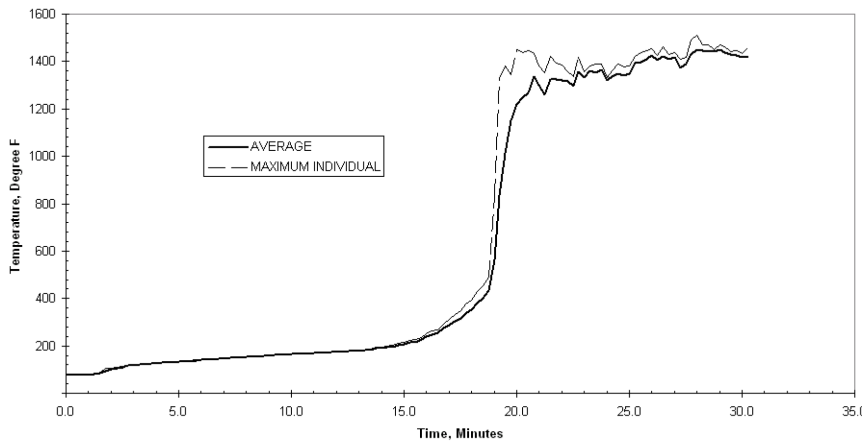


Figure 7 - Plot of Temperature of the Bottom Metal Gusset Plates vs. Time for Assembly No. 1

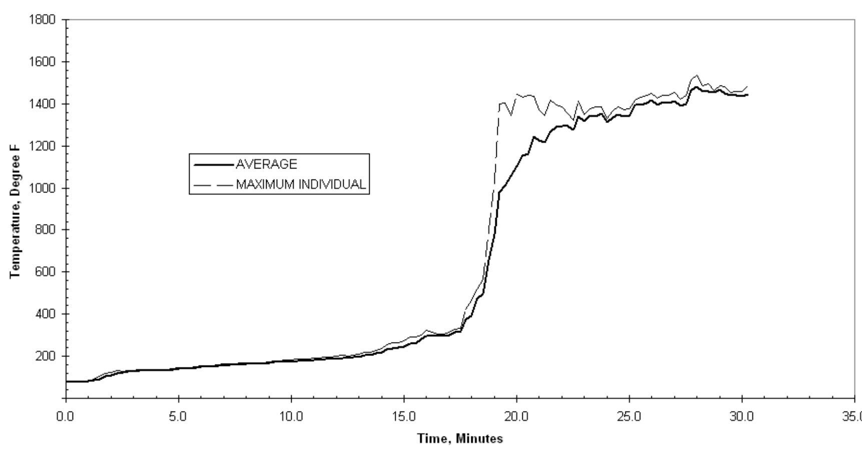


Figure 8 - Plot of Temperature of the Top Metal Gusset Plates vs. Time for Assembly No. 1

Temperatures of the Unexposed Side of Gypsum Board – The average and maximum temperatures of the unexposed surface just before the gypsum board fall off (17 min 15 sec) were 646°F and 965°F respectively. The individual temperature was recorded by thermocouple number 59. A plot of these temperatures can be seen on Figure 9.

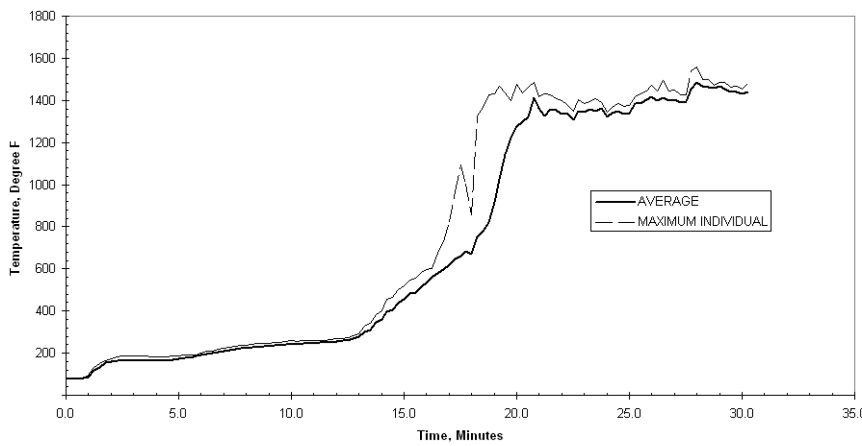


Figure 9 - Plot of Temperature of the Unexposed Surface of Gypsum Board vs. Time for Assembly No. 1

Temperatures Between the Sub Floor and Carpet Padding – The average and maximum temperatures between the sub floor and carpet padding just before the moment of collapse (30 min 8 sec) were 383°F and 704°F respectively. The individual temperature was recorded by thermocouple number 14. A plot of these temperatures can be seen on Figure 10.

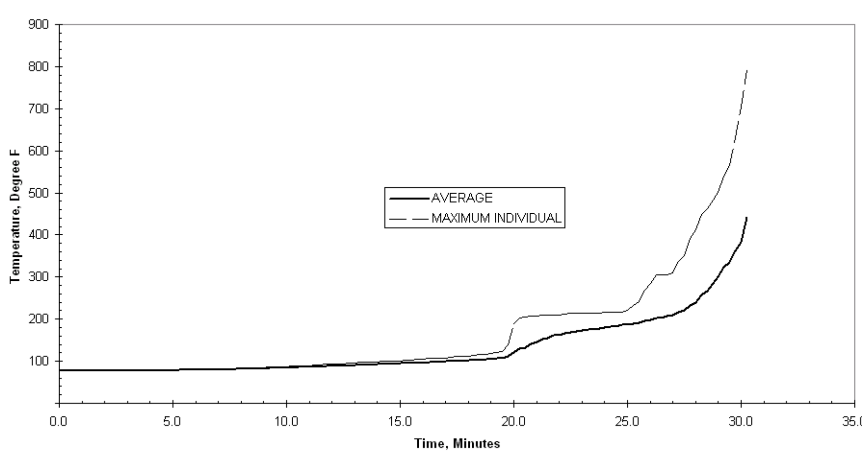


Figure 10 - Plot of Temperature of the Top of Subfloor vs. Time for Assembly No. 1

Temperatures Between the Carpet Padding and Carpet – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (30 min 8 sec) were 181°F and 221°F respectively. The individual temperature was recorded by thermocouple number 27. A plot of these temperatures can be seen on Figure 11.

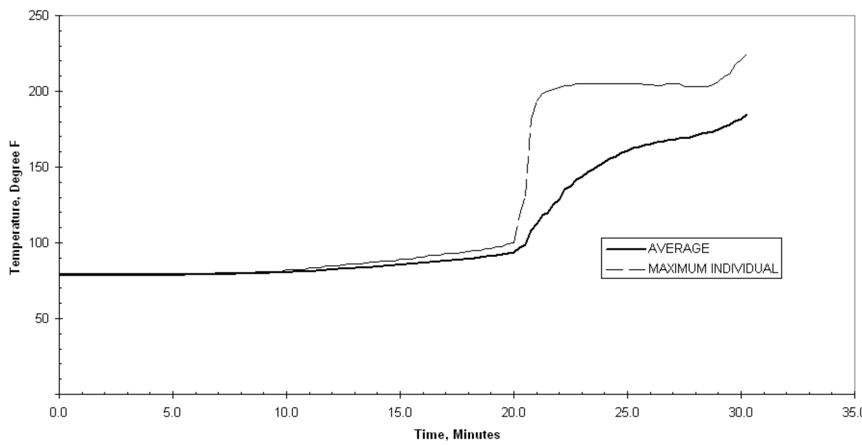


Figure 11 - Plot of Temperature of the Carpet Padding vs. Time for Assembly No. 1

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (30 min 8 sec) were 172°F and 196°F respectively. The individual temperature was recorded by thermocouple number 92. A plot of these temperatures can be seen on Figure 12.

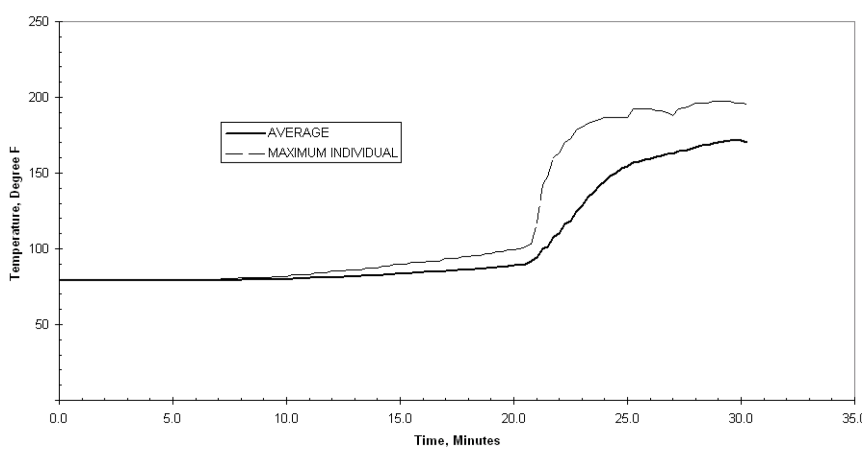


Figure 12 - Plot of Temperatures of the Unexposed Surface vs. Time for Assembly No. 1

Temperatures over the Can Lights – The average and maximum temperatures over the can lights just before the moment of collapse (30 min 8 sec) were 1437°F and 1508°F respectively. The individual temperature was recorded by thermocouple number 102. A plot of these temperatures can be seen on Figure 13.

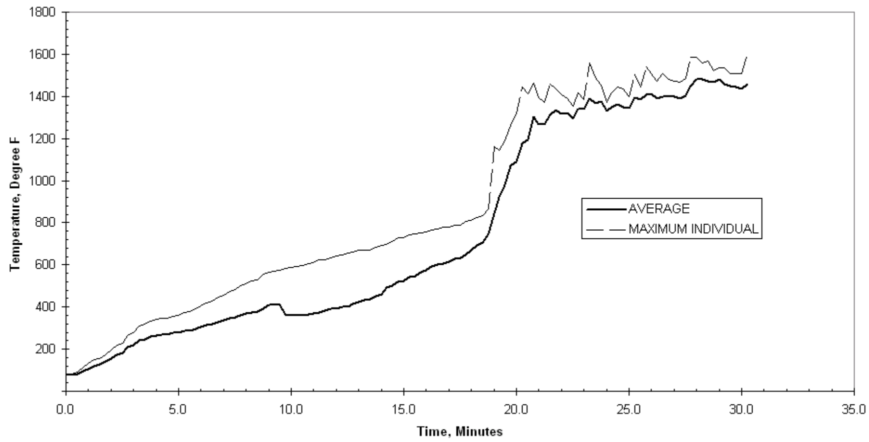


Figure 13 - Plot of Temperatures over the Can Lights vs. Time for Assembly No. 1

Temperatures over the Flexible Duct at Junction – The average and maximum temperatures over the flexible duct at junction just before the moment of collapse (30 min 8 sec) were 1431°F and 1467°F respectively. The individual temperature was recorded by thermocouple number 108. A plot of these temperatures can be seen on Figure 14.

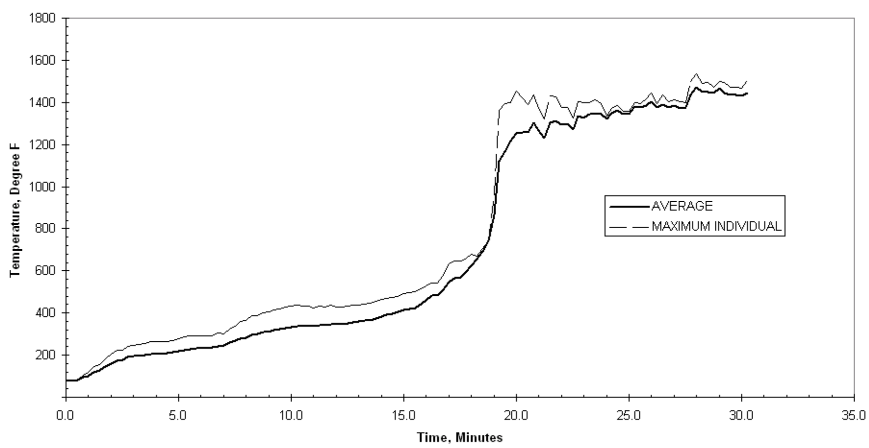


Figure 14 - Plot of Temperatures over the Flexible Duct at Junction vs. Time for Assembly No. 1

Temperatures over the Flexible Duct at Center Span – The average and maximum temperatures over the flexible duct at center span just before the moment of collapse (30 min 8 sec) were 1445°F and 1508°F respectively. The individual temperature was recorded by thermocouple number 110. A plot of these temperatures can be seen on Figure 15.

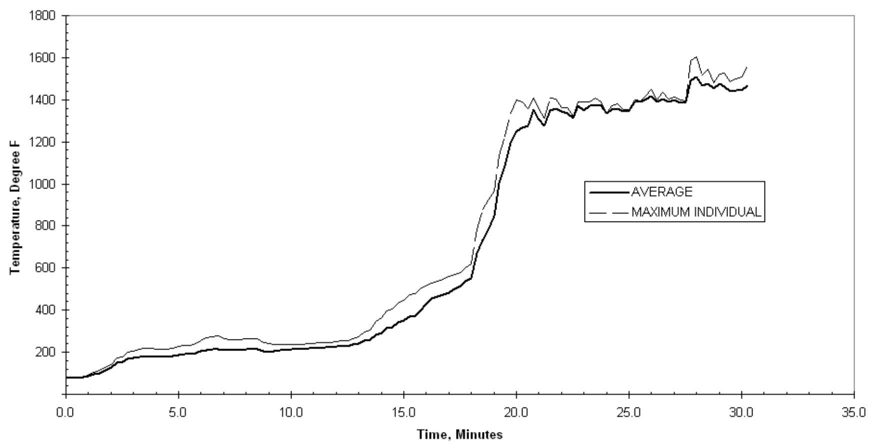


Figure 15 - Plot of Temperatures over the Flexible Duct at Center Span vs. Time for Assembly No. 1

Temperatures over the Rigid Duct – The average and maximum temperatures over the rigid duct just before the moment of collapse (30 min 8 sec) were 1417°F and 1418°F respectively. The individual temperature was recorded by thermocouple number 112. A plot of these temperatures can be seen on Figure 16.

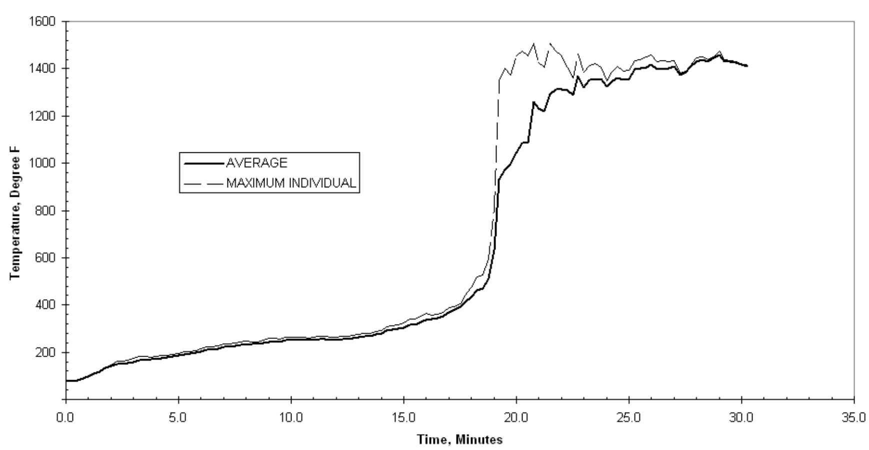


Figure 16 - Plot of Temperatures over the Rigid Duct vs. Time for Assembly No. 1

Temperatures of the Truss Splice Behind Connection of Metal Gussets – The average and maximum temperatures of the truss splice behind connection of metal gussets just before the moment of collapse (30 min 8 sec) were 1463°F and 1495°F respectively. The individual temperature was recorded by thermocouple number 114. A plot of these temperatures can be seen on Figure 17.

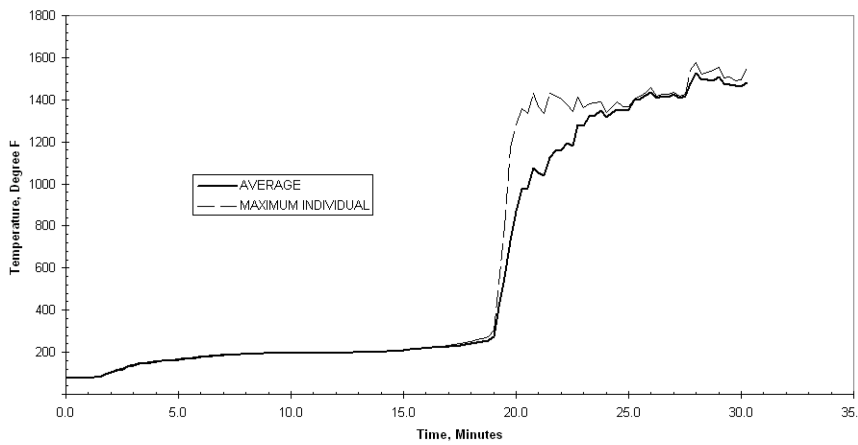


Figure 17 - Plot of Temperatures of the Truss Splice Behind Connection of Metal Gussets vs. Time for Assembly No. 1

Temperatures of the Truss Splice 2 in. from Metal Gussets – The average and maximum temperatures of the truss splice 2 in. from metal gussets just before the moment of collapse (30 min 8 sec) were 1466°F and 1525°F respectively. The individual temperature was recorded by thermocouple number 115. A plot of these temperatures can be seen on Figure 18.

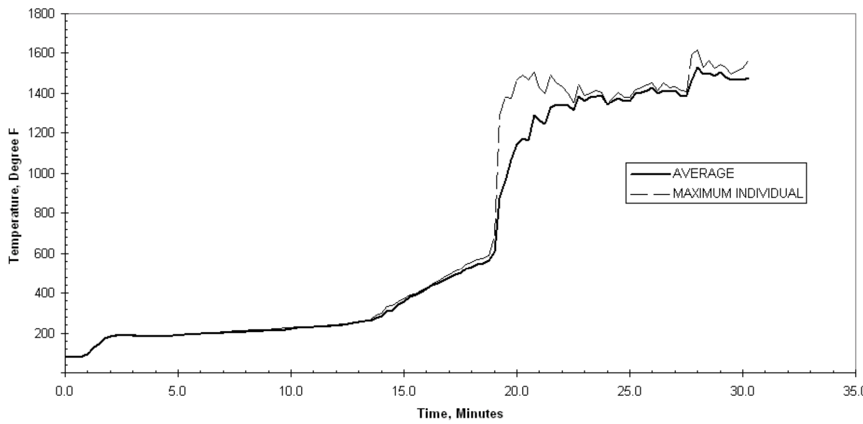


Figure 18 - Plot of Temperatures of the Truss Splice 2 in. from Metal Gussets vs. Time for Assembly No. 1

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 19. The location of each deflection transducer can be seen in Appendix A under Test Assembly 1.

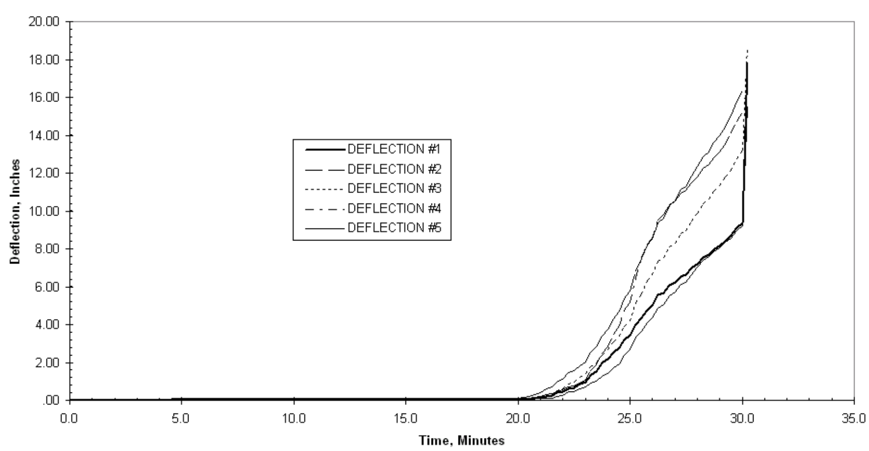


Figure 19 - Plot of Deflections vs. Time for Assembly No. 1

Test Record No. 2

Materials

Materials described in section General and used in Assembly No. 2 include 2 by 6 bearing plates, subfloor (OSB), carpet and padding, and tack strips. Additional materials are described below.

Trusses - The glued finger jointed trusses were nominally 14 in. deep, 14 ft long fabricated from nominal 2 in. by 2 in. wood members with nominal 2 in. 3 in. wide top and bottom chords and had an average weight of 34.11 lb. The top and bottom chords measured 2-1/2 in. wide by 1-1/2 in. high. The web members measured 1-1/2 in. wide by 1-1/2 in. high and the fingers penetrated 3/4 in. into the top and bottom chords. Nominal 2 in. by 6 in. and 2 in. by 8 in. wood members were used as vertical members inside each truss. Two nominal 2 by 8 in. sections of lumber were located at the outer edges of the trusses at the bearing location. Two nominal 2 by 6 in. sections of lumber were located 10-1/4 in. on each side of the truss centerline. The moisture content of the truss members ranged from 11.2 to 13.1 percent and averaged 12.24 percent.

Rim Band – The nominal 2 in. by 4 in. dimensional lumber measured 1-1/2 in. by 3-1/2 in.

Erection of Test Assembly

Nominal 2 in. by 6 in. structural grade wood bearing plates were placed on top of the steel angles. The trusses were placed on the wood bearing plates and spaced 24 in. OC starting at the East West centerline of the assembly. At the North and South ends of the assembly, additional trusses, not in the field of the fire test, were placed over the vermiculite concrete in order stabilize the plywood subfloor. The average bearing at each end of the truss was 5 in. The trusses were fastened to each bearing plate with two No. 16d nails.

Along the east and west edges of the test assembly, nominal 2 in. by 4 in. wood headers (rim band) were placed perpendicular to the trusses and fastened to the top chord of each truss with two No. 16d nails.

A 1/4 in. wide bead of adhesive was placed on the top chord of the trusses. The plywood sub-floor was placed on the trusses with the 8 ft long edges positioned perpendicular to the trusses and the ends butted and centered over trusses, with adjacent end joints staggered 4 ft. A 1/8 in. wide bead of adhesive was placed on the tip of the tongue and groove ends of the subfloor before sliding the panels together. The plywood was secured to the trusses with 1-7/8 in. long ringshank underlayment nails spaced 6 in. OC at the perimeter and 12 in. OC in the field with nails 1 in. from the edge of each panel.

The pre-nailed tack strips were secured to the subfloor around the perimeter of the assembly approximately 2 in. from the inside edge of the test frame.

The 6 ft wide carpet padding had joints spaced 6 ft 12 ft and 17-1/4 ft starting at the South edge of the assembly. The carpet padding was secured to the subfloor with 1/4 in. long staples spaced 18 in. OC around the perimeter of each laid piece of padding.

The 14-1/6 ft wide by 17-5/6 ft long roll of carpet was laid on top of the carpet padding. The carpet was stretched tight and secured to the carpet gripper nailing strips located at the perimeter of the entire assembly.

Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The location of instrumentation within the furnace and on the test sample are shown in Appendix A.

The temperatures of the wood trusses were measured with 20 thermocouples. Thermocouple numbers 31-40 were located on the bottom of the trusses and thermocouple numbers 41-50 were located on the side of trusses mid depth facing North and stapled to the trusses.

The temperatures within the interstitial space were measured with 26 thermocouples. Thermocouple numbers 51-60 were located at mid depth. Thermocouple numbers 61-70 were located on the bottom of the subfloor. Thermocouple numbers 71-73 were located on the bottom glued finger joints nearest center of assembly facing North and thermocouple numbers 74-76 were located on the top glued finger joints nearest center of assembly facing North.

The temperatures between the subfloor and carpet padding were measured with 15 thermocouples and numbered 1-15.

The temperatures on top of the carpet padding (between the carpet padding and carpet) were measured with 15 thermocouples and numbered 16-30.

The unexposed temperatures were measured with 13 thermocouples and numbered 77-89. Each of the unexposed surface thermocouples was covered with a 6 by 6 in. dry ceramic fiber pad.

The deflection of the assembly was measured with five electronic transducers.

There were a total of six camera views taken during the fire exposure period. One camera was positioned in the furnace recording the exposed surface of the assembly. Four other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 20

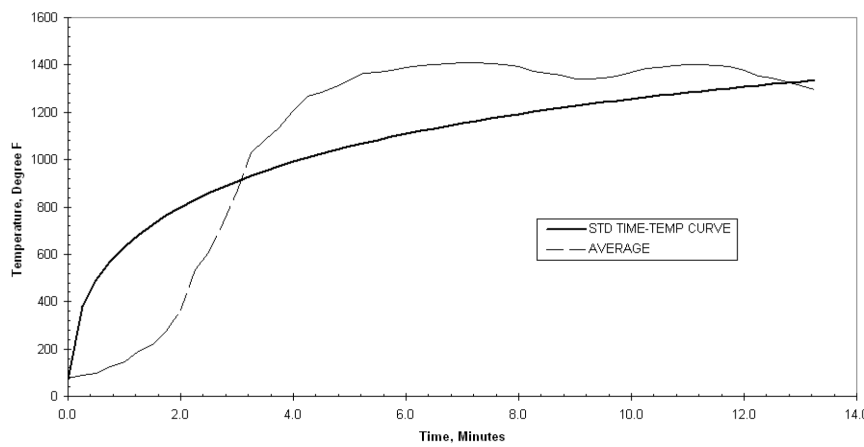


Figure 20 - UL263 (ASTM E119) Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Assembly No. 2

The furnace pressure and oxygen concentration are presented in Figure 21 and Figure 22.

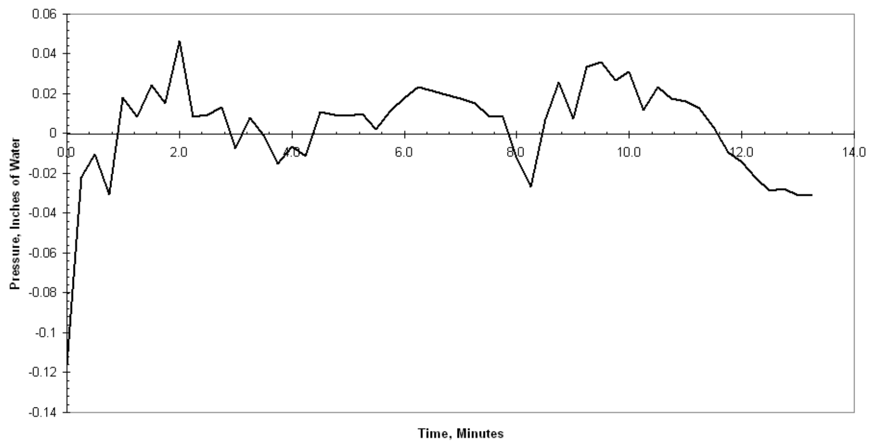


Figure 21 - Furnace Pressure vs. Time for Assembly No. 2

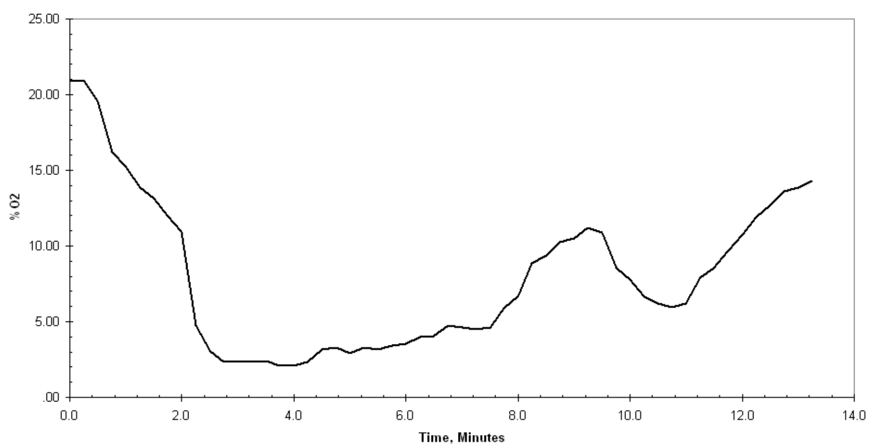


Figure 22 - Oxygen Content vs. Time for Assembly No. 2

Observations of the Exposed and Unexposed Surfaces - The observations made during the fire test are shown in Table 5. All references to dimensions are approximate.

Table 4 – Observations for Assembly No. 2

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
00:45	U	Smoke issued from the perimeter of the assembly.
00:54	E	The trusses & subfloor ingnited.
01:30	U	Smoke continued to issue from the perimeter of the assembly.
01:45	E	Visual observations could not be noted due to the heavy flaming.
02:00	U	Cracking noises heard.
02:30	U	Smoke issued through carpet at subfloor joints.
02:30	E	Cracking noises heard.
03:00	E	Flaming embers were floating in the furnace chamber.
04:00	U	The intensity of the smoke increased.
05:45	U	Char spots noted in the carpet at the subfloor joint locations.
07:00	U	Smoke intensity increased at the subfloor joint locations.
07:30	U	Movement of the firefighters was noted.
08:00	U	Popping noises heard.
08:12	U	The weights at the south end dropped.
08:45	U	Popping noises heard.
08:45	E	Two popping noises were heard.
09:30	E	A popping noise was heard.
09:45	U	Smoke intensity increased. Popping noised heard.
09:45	E	A popping noise was heard.
10:00	E	A popping noise was heard.
10:54	E	An angle member in one the center trusses was consumed.
11:30	E	The center trusses seem to be in the worst condition.
11:45	U	Flame through on west edge of assembly.
13:06	E/U	Structural collapse occurred. Furnace fire extinguished.

Temperatures of the Trusses - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom chords nearest the fire 250°F or the time required to raise the temperature on the bottom chords 325°F at any point. The average temperature measured on the bottom chords of the trusses was 80°F before the test. Therefore, the average limiting temperature was 330°F and the individual limiting temperature was 405°F.

The maximum individual limiting temperature for the finish rating was reached at 15 seconds as recorded by thermocouple number 36. A plot of the finish rating temperatures can be seen on Figure 23.

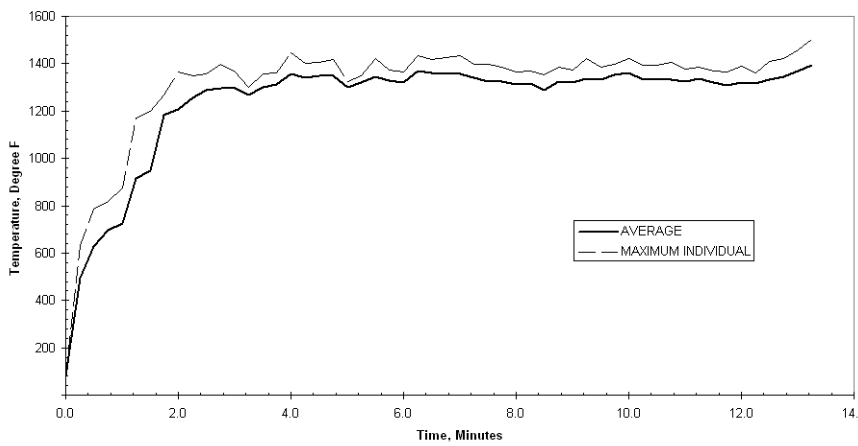


Figure 23 - Plot of Temperatures of Bottom of Wood Trusses vs. Time for Assembly No. 2

Temperatures at Mid Depth on the Side the Wood Trusses – The average and maximum temperatures of the sides of the wood trusses just before the moment of collapse (13 min 6 sec) were 1378°F and 1484°F respectively. The individual temperature was recorded by thermocouple number 43. A plot of these temperatures can be seen on Figure 24.

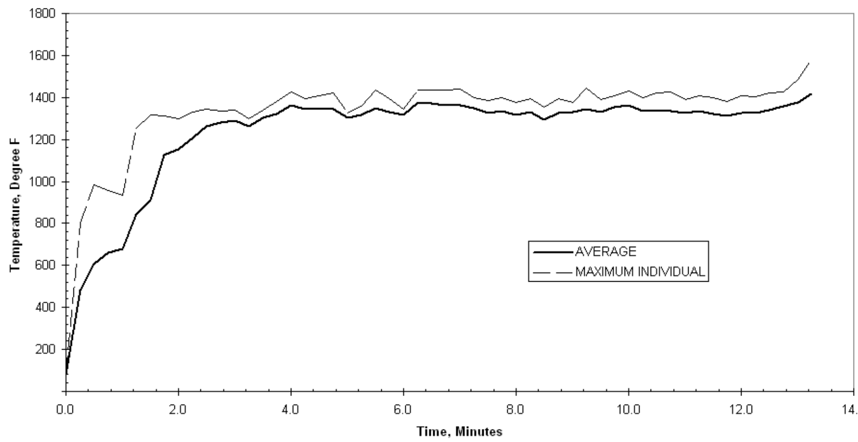


Figure 24 - Plot of Temperatures of Mid Depth on Side of Wood Trusses vs. Time for Assembly No. 2

Temperatures of the Mid Depth Between Wood Trusses – The average and maximum temperatures of the mid depth between the wood trusses just before the moment of collapse (13 min 6 sec) were 1381°F and 1521°F respectively. The individual temperature was recorded by thermocouple number 55. A plot of these temperatures can be seen on Figure 25.

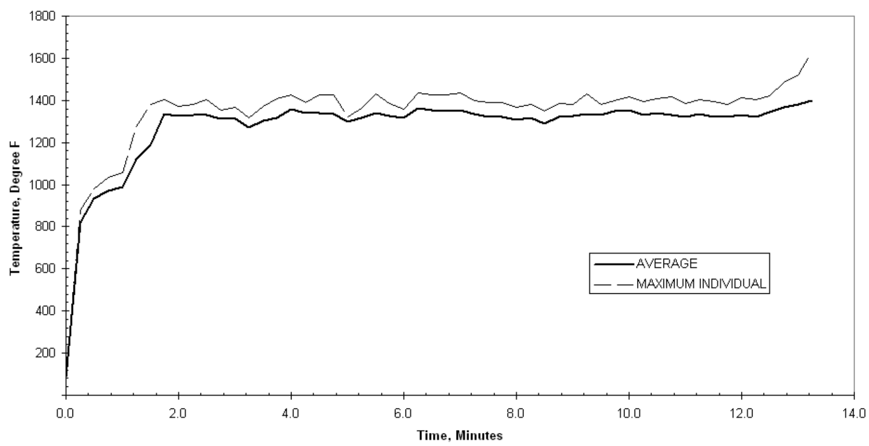


Figure 25 - Plot of Temperatures of Mid Depth Between Wood Trusses vs. Time for Assembly No. 2

Temperatures of the Sub Floor Between Wood Trusses – The average and maximum temperatures of the sub floor between the wood joists just before the moment of collapse (13 min 6 sec) were 1377°F and 1476°F respectively. The individual temperature was recorded by thermocouple number 66. A plot of these temperatures can be seen on Figure 26

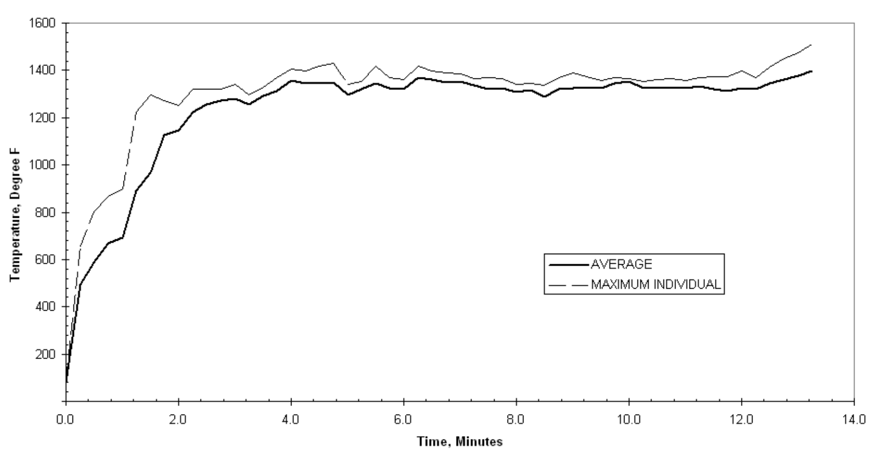


Figure 26 - Plot of Temperatures of Below Subfloor vs. Time for Assembly No. 2

Temperatures of the Glued Finger Joints – The average and maximum temperatures of the top glued finger joints just before the moment of collapse (13 min 6 sec) were 1388°F and 1448°F respectively. The individual temperature was recorded by thermocouple number 74. The average and maximum temperatures of the bottom glued finger joints just before the moment of collapse (13 min 6 sec) were 1378°F and 1439°F respectively. The individual temperature was recorded by thermocouple number 71. A plot of the glued finger joint temperatures can be seen on Figure 27 and Figure 28 respectively.

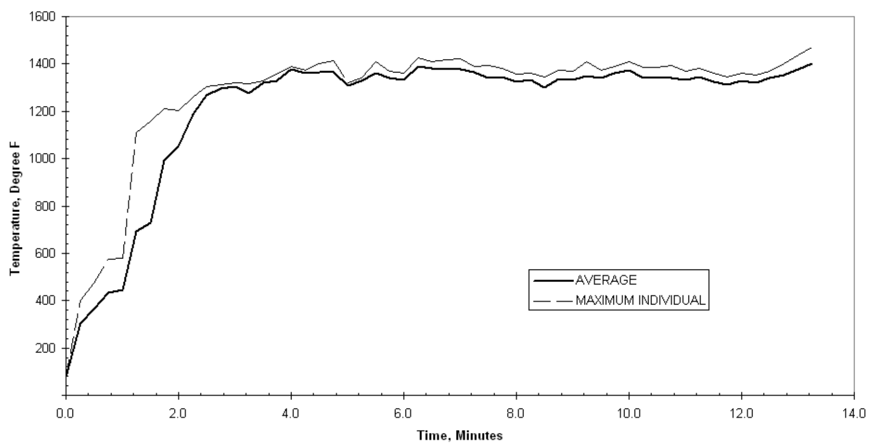


Figure 27 - Plot of Temperatures of Top Glued Finger Joints vs. Time for Assembly No. 2

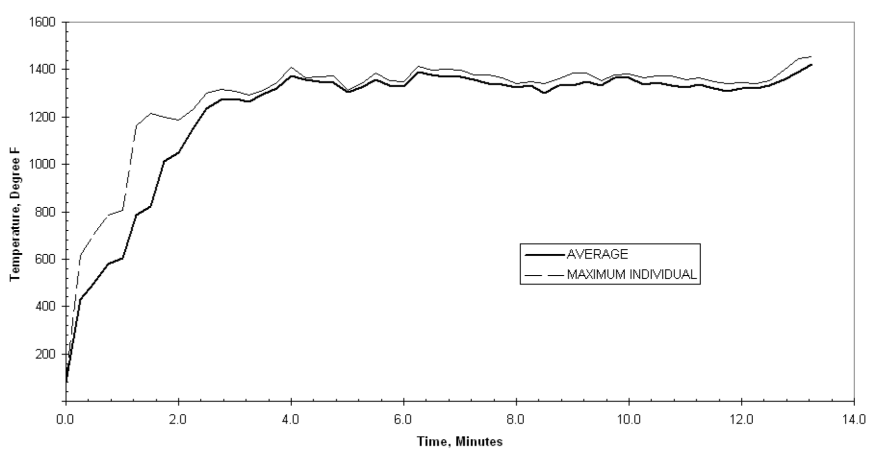


Figure 28 - Plot of Temperatures of Bottom Glued Finger Joints vs. Time for Assembly No. 2

Temperatures Between the Sub Floor and Carpet Padding – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (13 min 6 sec) were 701°F and 1353°F respectively. The individual temperature was recorded by thermocouple number 4. A plot of these temperatures can be seen on Figure 29

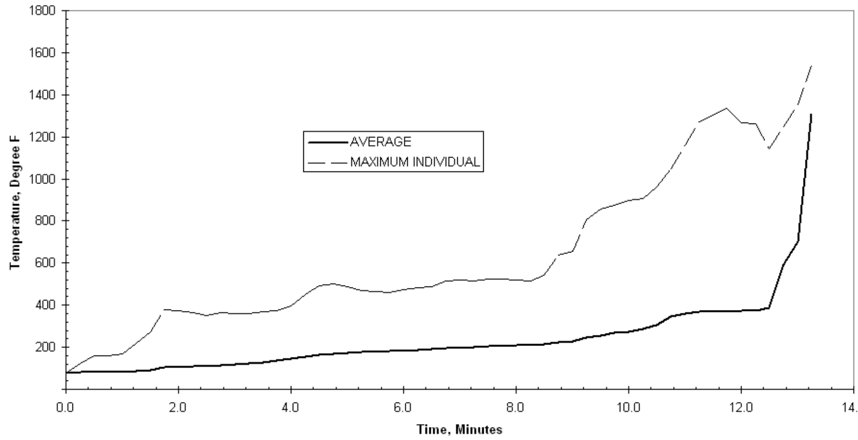


Figure 29 - Plot of Temperatures of Top of Subfloor vs. Time for Assembly No. 2

Temperatures Between the Carpet Padding and Carpet – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (13 min 6 sec) were 602°F and 1320°F respectively. The individual temperature was recorded by thermocouple number 24. A plot of these temperatures can be seen on Figure 30.

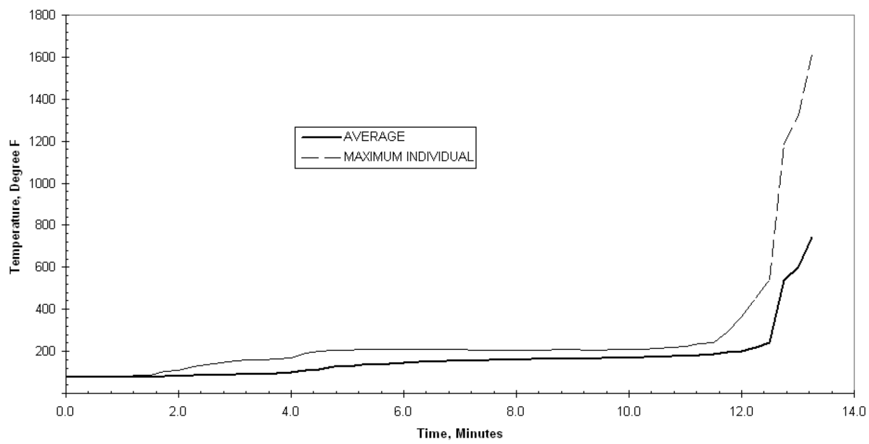


Figure 30 - Plot of Temperatures of Carpet Padding vs. Time for Assembly No. 2

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (13 min 6 sec) were 448°F and 1306°F respectively. The individual temperature was recorded by thermocouple number 82. A plot of these temperatures can be seen on Figure 31.

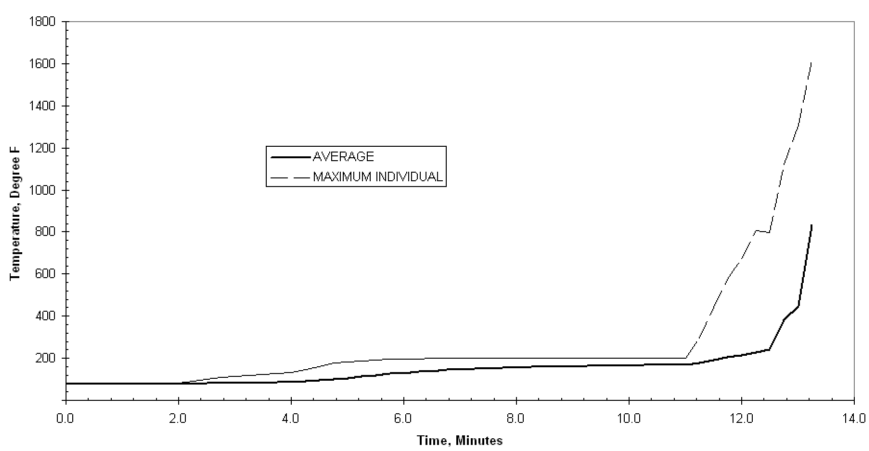


Figure 31 - Plot of Temperatures of Unexposed Surface vs. Time for Assembly No. 2

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 32. The location of each deflection transducer can be seen in Appendix A under Test Assembly 2.

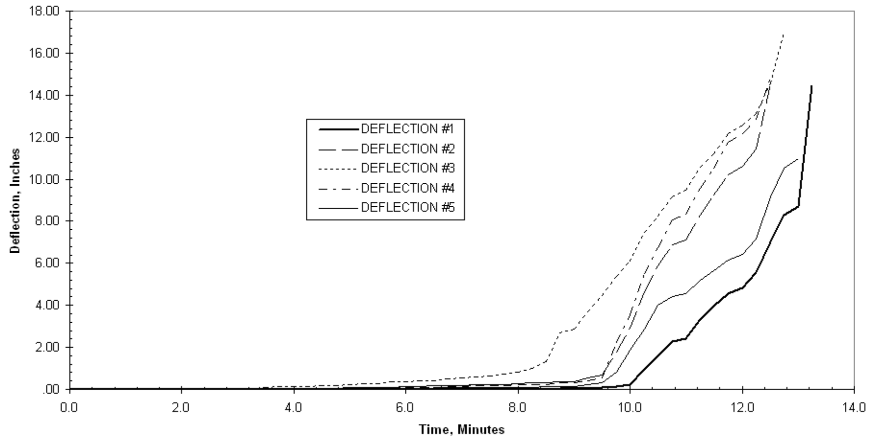


Figure 32 - Plot of Deflections vs. Time for Assembly No. 2

Test Record No. 3:

Materials

Materials described in Section General and used in Assembly No. 3 include 2 by 6 bearing plates, subfloor (OSB), carpet and padding, and tack strips. Additional materials are described below.

Trusses – There were three different metal gusseted truss configurations used for Assembly 3. The first parallel chord trusses (1F1G Girder Trusses) were 14 in. deep, 13 ft 10 in. long fabricated from nominal 2 in. by 4 in. wood members and had an average weight of 135.05 lbs. The girder trusses were two 1F1G trusses fastened together with steel bands and 6 in. long screws. There was a splice of the bottom chord located 6 ft 5 in. from the east side of the trusses. The second parallel chord trusses (1F1) were 14 in. deep, 13 ft 10 in. long fabricated from nominal 2 in. by 4 in. wood members and had an average weight of 56.58 lbs. There was a splice of the bottom chord located 6 ft 5 in. from the east side of the trusses. The third parallel chord trusses (1F2) were 14 in. deep, 10 ft 10in. long fabricated from nominal 2 in. by 4 in. wood members and had an average weight of 46.7 lbs. There was a splice of the bottom chord located 3 ft 5 in. from the east side of the trusses. The nominal 4 in. side of the truss members was oriented in the horizontal direction. The truss members were secured together with galvanized steel plates measuring 0.036 in. thick. The plates contained teeth projecting perpendicular to the plane of the plate. The moisture content of the truss members ranged from 12.1 to 20.3 percent and averaged 16.2 percent.

Rim Board – The nominal 2 in. by 4 in. dimensional lumber measured 1-1/2 in. by 3-1/2 in.

Strongback – The nominal 2 in. by 6 in. dimensional lumber measured 1-1/2 in. by 5-1/2 in.

LVL Beam – Each LVL beam measured 12 ft 1/4 in. long by 14 in. tall by 1-3/4 in. thick and weighted 84.5 lbs.

Rim Board – Each rim board measured 12 ft 1/4 in. long by 14 in. tall by 1-1/4 in. thick and weighted 50.8 lbs.

Wood I-Joists – The wood I-joists were provided in 10 ft lengths and were 14 in. deep. The web was composed of particleboard measuring 10-7/8 in. by 3/8 in. and the top and bottom chords were composed of solid lumber measuring 3-1/2 in. by 1-1/2 in. Each joist weighed approximately 41.9 lbs.

MIT Hanger – The connectors measured 3-3/4 in. wide by 14 in. deep and were composed of 0.057 in. thick steel. Each connector weighed approximately 1.4 lbs.

THA Hanger – The connectors measured 3-3/4 in. wide by 14 in. deep and were composed of 0.058 in. thick steel. Each connector weighed approximately 1.3 lbs.

Erection of Test Assembly

See Illustration 1 for detailed layout of Assembly 3.

Nominal 2 in. by 6 in. structural grade wood bearing plates were placed on top of the steel angles. Two 1F1 trusses were located at each North and South edges of the assembly. The outermost North and South trusses were not in the field of the fire test and were placed over the vermiculite concrete in order stabilize the plywood subfloor. The trusses were fastened to each bearing plate with two No. 16d nails.

The 1F1G girder trusses were located 6 ft North and South of the centerline of the assembly. The girder trusses were secured to the 2 in. by 6 in bearing plates with two 16d nails at each end.

Two THA hangers were fastened to the 1F1G Girder trusses 36-1/4 in. from the East edge of the assembly. Both hangers were positioned towards the assembly centerline.

Two LVL beams were secured together with two 3 in. long connector screws spaced 4 in. from the end and 12 in. on center thereafter. The LVL beam was secured to each THA hanger.

Five MIT hangers were secured to the east side of the LVL beam and five THA hangers were secured to the west side of the LVL beam. The hangers were spaced 24 in. OC.

On the West side of the LVL assembly one end of each 1F2 truss was secured to the 2 in. by 6 in. bearing plate with two 16d nails and the other end was secured the THA hangers. The trusses were spaced 24 in. OC.

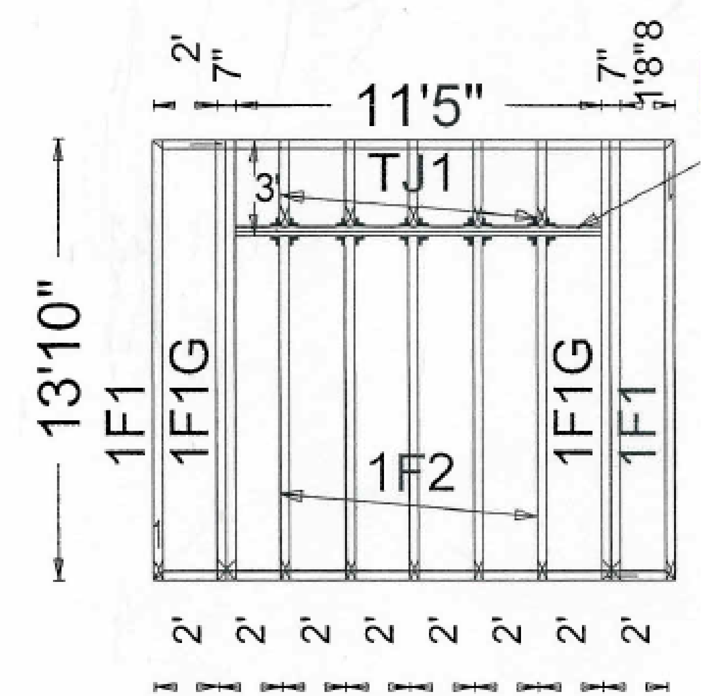
On the East side of the LVL assembly the wood I joists were secured the 2 in. by 6 in wood bearing plate and the other end was secured to the MIT hangers. The wood I joists were spaced 24 in. OC.

At the North and South ends of the assembly, two 1F1 trusses were installed. One truss was located 24 in. from the girder and the second truss was installed at the edge the test frame. Each end of the trusses were secured to the 2 in. by 6 in bearing plates with two 16d nails at each end.

Nominal 2 in. by 6 in. structural grade strongbacks were run perpendicular to the vertical member of the trusses located 5 ft 7-1/2 in. from the West side of the assembly. The strongback was secured to the vertical wood members of the trusses with two No. 16d nails at each strongback / truss interface.

Along the East and West edges of the test assembly, nominal 2 in. by 4 in. wood headers (rim band) were placed perpendicular to the trusses and fastened to the top chord of each truss with two No. 16d nails.

Along the East edge of the assembly, the rim board was placed perpendicular to the wood I-joists and fastened to the top chord of each wood I joist with two 16d nails.



ILL 1 – Layout of Assembly No. 3

A 1/4 in. wide bead of adhesive was placed on the top chord of the trusses. The plywood sub-floor was placed on the trusses with the 8 ft long edges positioned perpendicular to the trusses and the ends butted and centered over trusses, with adjacent end joints staggered 4 ft. A 1/8 in. wide bead of adhesive was placed on the tip of the tongue and groove ends of the subfloor before sliding the panels together. The plywood was secured to the trusses with 1-7/8 in. ringshank underlayment nails spaced 6 in. OC at the perimeter and 12 in. OC in the field with nails 1 in. from the edge of each panel.

The plywood sub-floor was placed and secured on the wood I-joists in the same manner as the trusses. Joints in the OSB subfloor were placed at the center of the truss girders and LVL beam to simulate the discontinuity at a stairwell opening.

The pre-nailed tack strips were secured to the subfloor around the perimeter of the assembly approximately 2 in. from the inside edge of the test frame. No tack strips were placed over the wood I joists.

The 6 ft wide carpet padding had joints spaced 6 ft,12 ft and 17 ft 2 in. starting at the West edge of the assembly. The carpet padding was secured to the subfloor with 1/4 in. long staples spaced 18 in. OC around the perimeter of each laid piece of padding. No padding was placed over the wood I joists.

The 14 ft 2 in. wide by 17 ft 10 in. long roll of carpet was laid on top of the carpet padding. The carpet was stretched tight and secured to the carpet gripper nailing strips located at the perimeter of the entire assembly. A section measuring 11 ft 5 in by 36-1/4 in. was cut from the carpet as to not cover the wood I-joists.

Sample

The fire endurance test was conducted on the assembly described previously in this Report under "Erection Of Test Assembly". Test results relate only to items tested.

Method

The location of instrumentation within the furnace and on the test sample are shown in Appendix A.

The temperatures of the wood trusses were measured with 20 thermocouples numbered 31-40 were located on the bottom of the trusses and thermocouple numbers 41-50 were located on the side of trusses mid depth facing North and stapled to the trusses.

The temperatures of the wood I joists were measured with 2 thermocouples numbered 92 and 93 and were located on the bottom of the joists.

The temperatures of the LVL assembly were measured with 2 thermocouples numbered 90 and 91 and were located on the bottom of the LVLs.

The temperatures of the metal Connectors were measured with 4 thermocouples numbered 94-97 and were located on the bottom of the metal connectors.

The temperatures within the interstitial space were measured with 26 thermocouples. These thermocouples were numbered 51-60 and located at mid depth. Thermocouple numbers 61-70 were located on the bottom of the subfloor. Thermocouples numbered 74-76 were located on the bottom metal gusset plates nearest center of assembly facing North. Thermocouples numbered 71-73 were located on the top metal gusset plates nearest center of assembly facing North.

The temperatures between the subfloor and carpet padding were measured with 15 thermocouples and numbered 1-15.

The temperatures on top of the carpet padding (between the carpet padding and carpet) were measured with 15 thermocouples and numbered 16-30.

The unexposed surface temperatures were measured with 13 thermocouples and numbered 77-89. Each thermocouple was covered with a 6 by 6 in. dry ceramic fiber pad.

The deflection of the assembly was measured with five electronic transducers.

There were a total of six camera views taken during the fire exposure period. One camera was positioned in the furnace recording the exposed surface of the assembly. Four other cameras recorded separate angles of the unexposed surface of the assembly and one infrared camera recorded the unexposed surface temperatures.

Results

Throughout the test, observations were made of the character of the fire, of the conditions of the exposed and unexposed surfaces, and of other events relative to the fire resistance performance of the assembly.

Character and Distribution of the Furnace Fire - The furnace fire was luminous and well distributed throughout the test. A plot of the furnace temperature can be seen on Figure 33.

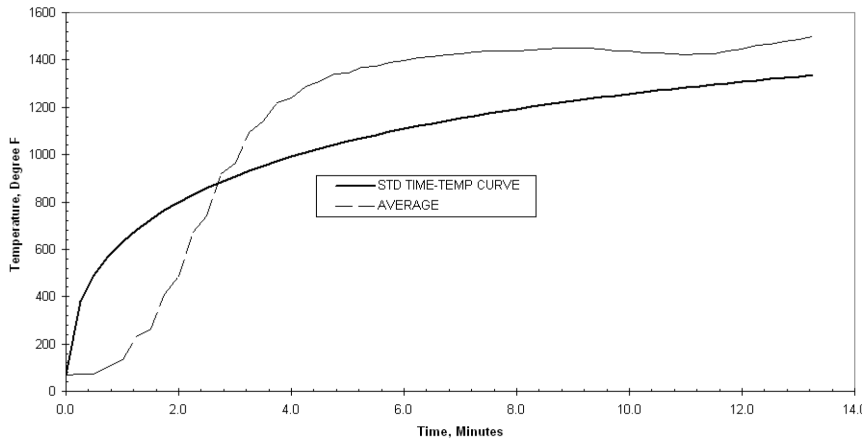


Figure 33 – UL263 (ASTM E119) Standard Time Temperature Curve and Average Furnace Temperature vs. Time for Assembly No. 3

The furnace pressure and oxygen concentration are presented in Figure 34 and Figure 35.

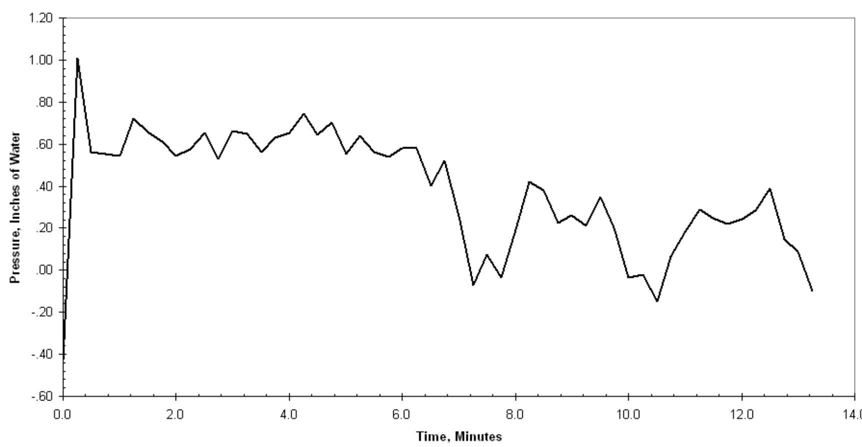


Figure 34 – Furnace Pressure vs. Time for Assembly No. 3

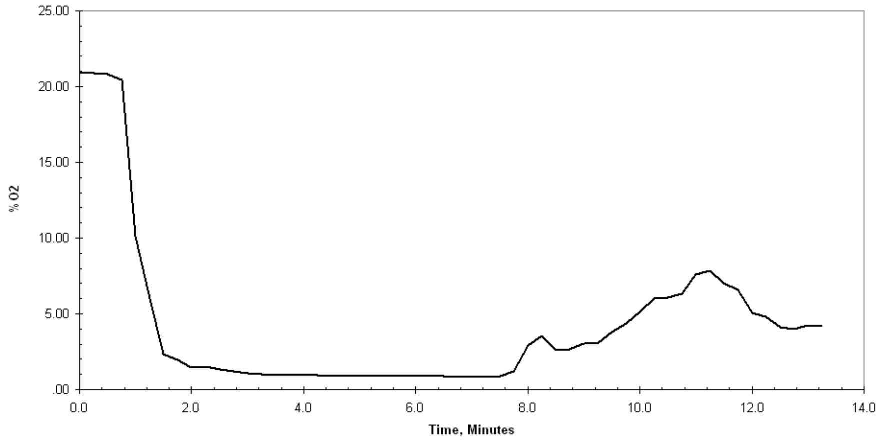


Figure 35 – Oxygen Content vs. Time for Assembly No. 3

Observations of the Exposed and Unexposed Surfaces - The following observations were made during the fire test are show in Table 6. All references to dimensions are approximate.

Table 5 - Observations for Assembly No. 3

Test Time, Min:Sec	Exposed (E) or Unexposed (U) Surface	Observations
00:15	E	Oil and dust on thermocouple wires flashed.
00:30	U	Smoke issued from under the carpet at the interface of the exposed subflooring.
00:30	E	Structural members ignited.
01:00	E	Cracking noises heard.
01:30	U	Smoke issued form the drain holes of the exposed subflooring.
01:30	E	Subflooring ignited.
02:00	U	The carpet was darkening near at the drain holes near the kneeling firefighters hands.
02:00	E	Furnace Chamber filled with heavy smoke.
03:30	U	The intensity of the smoke increased. Cracking noises were heard.
04:00	E	Heavy smoke continued in the furnace chamber.
04:30	U	Burn holes at the subflooring drain holes were increasing in size.
05:15	E	Bottom chords of the trusses were breaking apart and falling into the furnace chamber.
06:00	U	Noticeable deflection was noted at the center of the assembly.
06:00	E	Additional bottom chords falling into the furnace chamber.
07:30	U	The intensity of the smoke increased.
09:00	E	All structural members seem to be disconnected from the LVL.
10:00	U	Burn holes at the subflooring drain holes were increasing in size. The intensity of the smoke increased.
11:00	U	A gap began to develop at the side joint of the subflooring at the interface with the carpet
11:30	E	The LVL seems to have disconnected from the south girder. The south girder seems to be intact.
11:30	U	Flame through at the east subflooring joint.
12:30	U	Flame through at the west subflooring joint.
13:00	E	The north girder was falling apart.
13:20	E/U	Structural collapse occurred. Furnace fire extinguished.

Temperatures of the Trusses - The finish rating is defined as the time necessary to raise the average temperature measured on the face of the bottom chords nearest the fire 250°F or the time required to raise the temperature on the bottom chords 325°F at any point. The average temperature measured on the bottom chords of the trusses was 81°F before the test. Therefore, the average limiting temperature was 331°F and the individual limiting temperature was 406°F.

The maximum individual limiting temperature for the finish rating was reach at 30 seconds as recorded by thermocouple number 37. A plot of the finish rating temperatures can be seen on Figure 36.

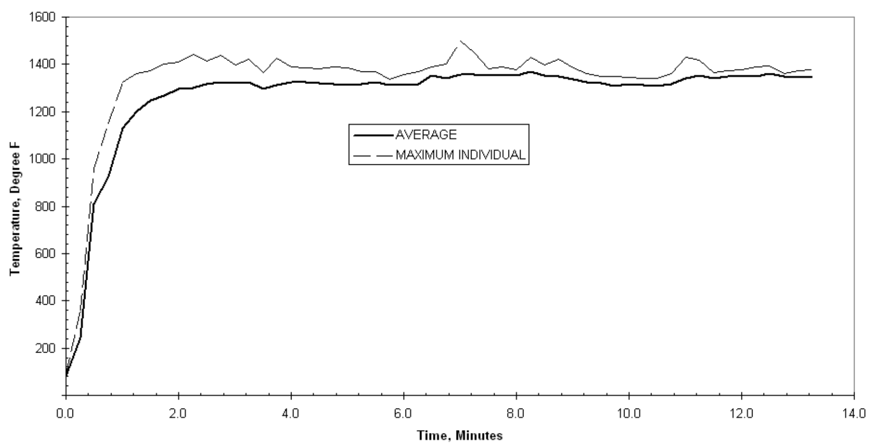


Figure 36 – Plot of Temperatures of Bottom of Wood Trusses vs. Time for Assembly No. 3

Temperatures at Mid Depth on the Side the Wood Trusses – The average and maximum temperatures of the sides of the wood trusses just before the moment of collapse (13 min 20 sec) were 1346°F and 1373°F respectively. The individual temperature was recorded by thermocouple number 46. A plot of these temperatures can be seen on Figure 37.

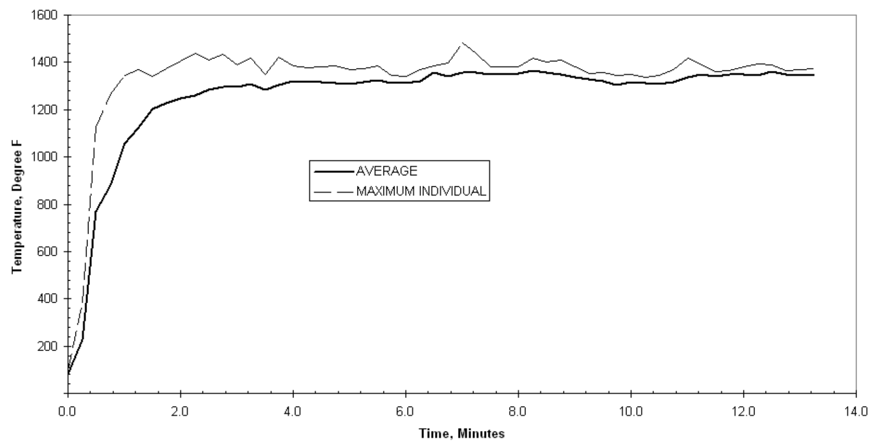


Figure 37 – Plot of Temperatures of Side of Wood Trusses vs. Time for Assembly No. 3

Temperatures of the Mid Depth Between Wood Trusses – The average and maximum temperatures of the mid depth between the wood trusses just before the moment of collapse (13 min 20 sec) were 1346°F and 1375°F respectively. The individual temperature was recorded by thermocouple number 59. A plot of these temperatures can be seen on Figure 38.

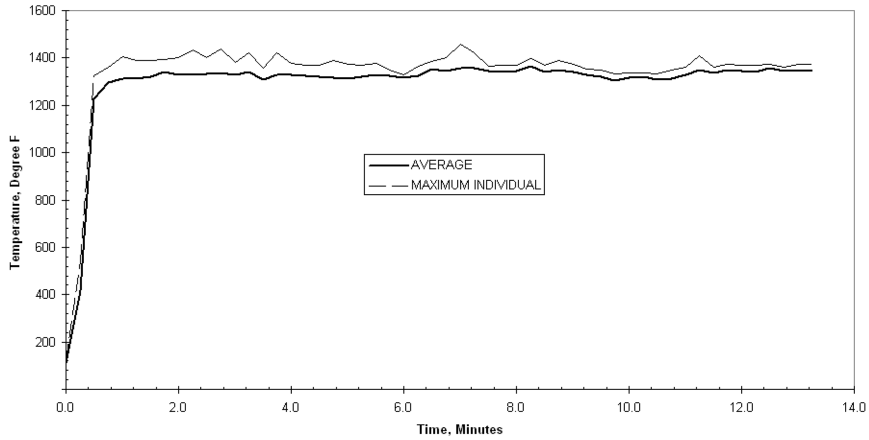


Figure 38 – Plot of Temperatures of Side of Wood Trusses vs. Time for Assembly No. 3

Temperatures of the Bottom of the Sub Floor Between Wood Trusses – The average and maximum temperatures of the sub floor between the wood trusses just before the moment of collapse (13 min 20 sec) were 1350°F and 1372°F respectively. The individual temperature was recorded by thermocouple number 70. A plot of these temperatures can be seen on Figure 39.

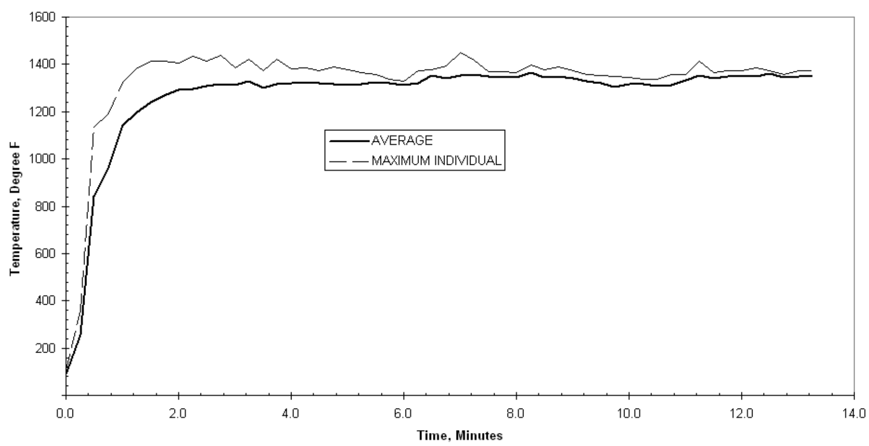


Figure 39 – Plot of Temperatures of the Bottom of the Subfloor between Wood Trusses vs. Time for Assembly No. 3

Temperatures of the Metal Gusset Plates – The average and maximum temperatures of the top metal gusset plates just before the moment of collapse (13 min 20 sec) were 1333°F and 1354°F respectively. The individual temperature was recorded by thermocouple number 73. The average and maximum temperatures of the bottom metal gusset plate just before the moment of collapse (13 min 20sec) were 1338°F and 1347°F respectively. The individual temperature was recorded by thermocouple number 74. A plot of the metal gusset temperatures can be seen on Figure 40 and Figure 41.

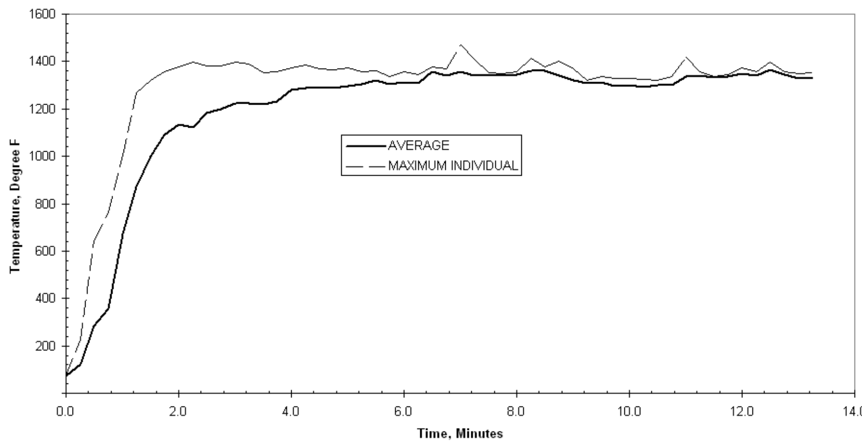


Figure 40 – Plot of Temperatures of the Top Metal Gusset Plates vs. Time for Assembly No. 3

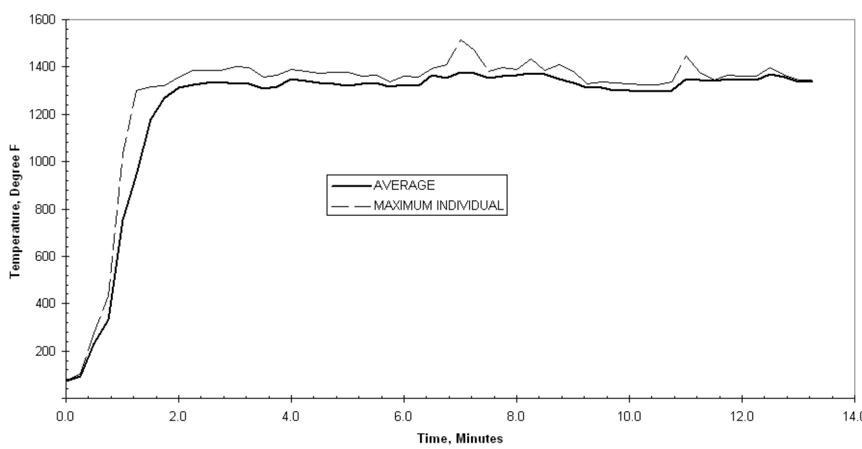


Figure 41 – Plot of Temperatures of the Bottom Metal Gusset Plates vs. Time for Assembly No. 3

Temperatures Between the Sub Floor and Carpet Padding – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (13 min 20 sec) were 597°F and 1424°F respectively. The individual temperature was recorded by thermocouple number 4. A plot of these temperatures can be seen on Figure 42.

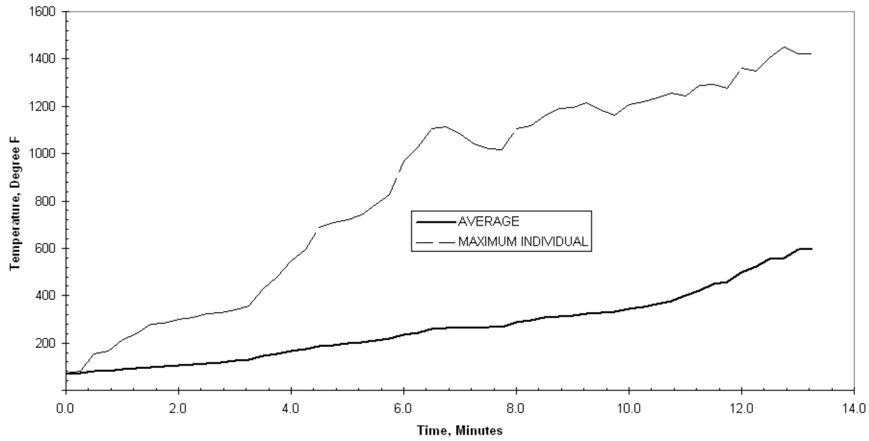


Figure 42 – Plot of Temperatures of the Top of the Subfloor vs. Time for Assembly No. 3

Temperatures Between the Carpet Padding and Carpet – The average and maximum temperatures between the sub floor and finish floor just before the moment of collapse (13 min 20 sec) were 489°F and 1397°F respectively. The individual temperature was recorded by thermocouple number 24. A plot of these temperatures can be seen on Figure 43.

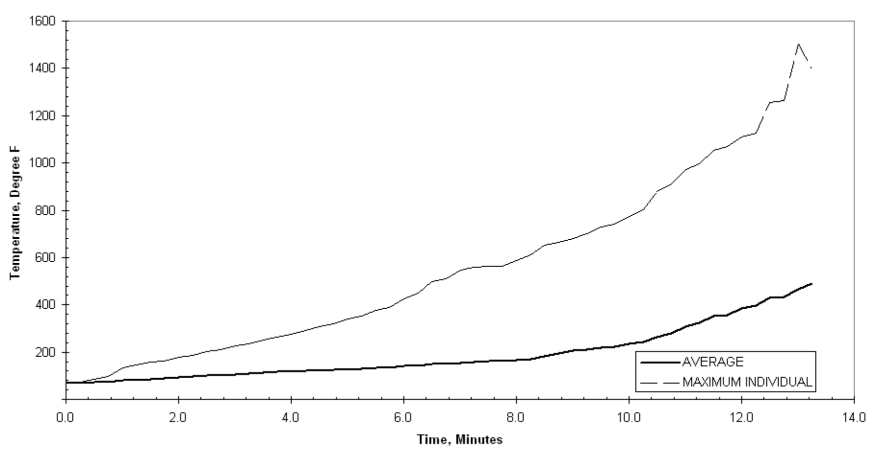


Figure 43 – Plot of Temperature of the Carpet Padding vs. Time

Temperatures of the Unexposed Surface – The average and maximum temperatures of the unexposed surface just before the moment of collapse (13 min 20 sec) were 480°F and 1273°F respectively. The individual temperature was recorded by thermocouple number 80. A plot of these temperatures can be seen on Figure 44.

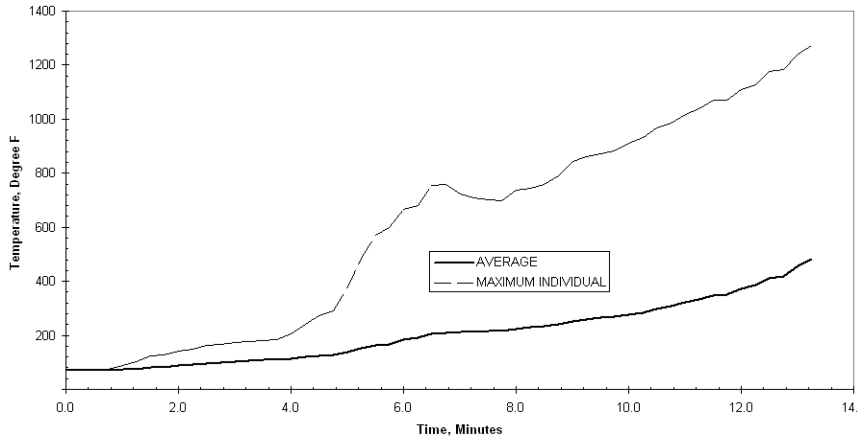


Figure 44 – Plot of Temperatures of the Unexposed Surface vs. Time

Temperatures of the LVL Assembly and Metal Connectors – The average and maximum temperatures of the LVL assembly and metal connectors just before the moment of collapse (13 min 15 sec) were 1347°F and 1367°F respectively. The individual temperature was recorded by thermocouple number 91. A plot of these temperatures can be seen on Figure 45. All temperatures on the LVL and metal connectors were observed to be similar.

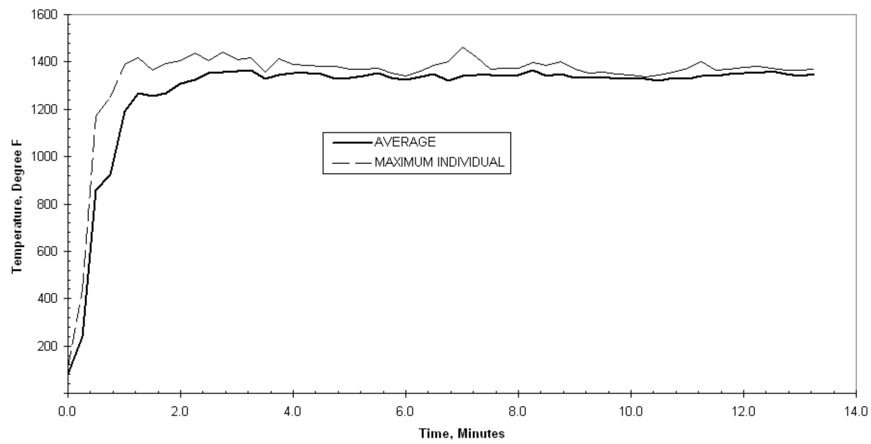


Figure 45 – Plot of Temperatures of the LVL Assembly and Metal Connectors vs. Time

Deflection of the Assembly - The deflection of the floor-ceiling assembly during the fire test is shown on Figure 46. The location of each deflection transducer can be seen in Appendix A under Test Assembly 3.

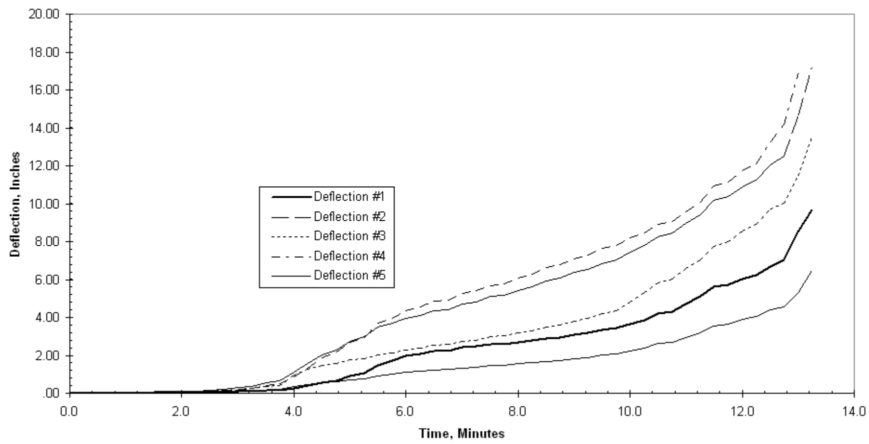


Figure 46 – Plot of Deflections vs. Time

Discussion

Furnace Conditions

The average temperatures within the furnace for the three tests were plotted for comparison in Figure 46

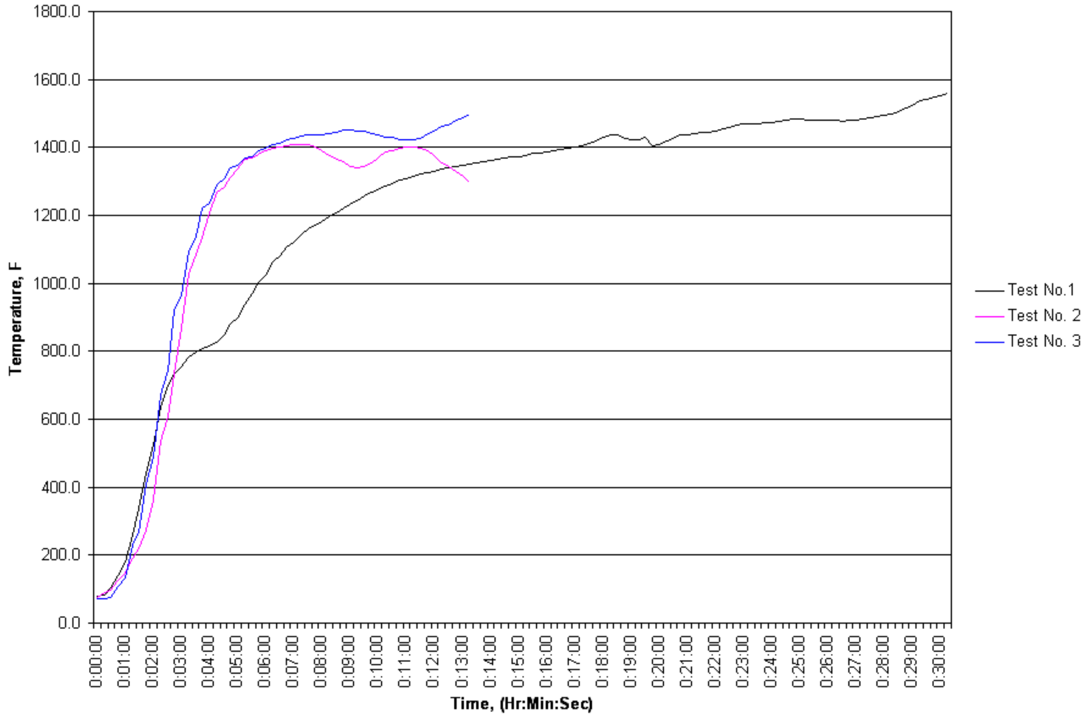


Figure 47 - Furnace Temperature vs. Time

The furnace temperature during the initial portion of Test Nos. 2 and 3 were significantly higher than recorded during Test No. 1 because the combustible supports and sub-floors for both of these assemblies were exposed to the furnace fire at the start of the test.

The oxygen content within furnace for the three tests were plotted for comparison in Figure 46

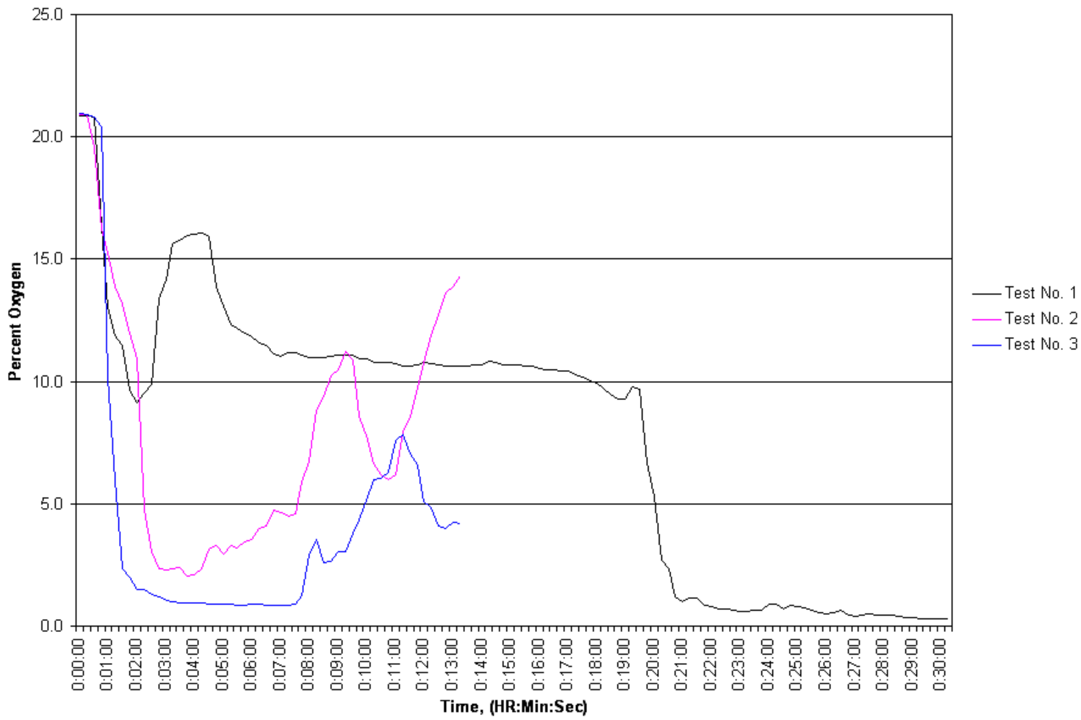


Figure 48 - Percent Oxygen vs. Time

The percent oxygen content at the beginning of the tests was approximately 20 to 23 percent and was reduced to approximately 9 percent during the tests when the ceiling was in place. The percent oxygen content dropped to near zero after the ceilings fell and the combustible supports and sub-floor were exposed to the furnace flames.

Overall, the conditions within the furnace during each of the three fire tests were sufficiently similar to enable a comparison of the structural performance of the samples when considering the state of the test samples.

Table 6 provides a summary of the temperature data for assemblies 1 through 3

Table 6 - Average temperature on exposed surface of sub-floor and average temperature on unexposed surface of floor.

Assembly No.	Average temperature of exposed (lower) surface of sub-floor 30 second before collapse (ºF)	Average temperature of unexposed (upper) surface of floor 30 second before collapse (ºF)
1	1444	171
2	1344	242
3	1346	419

It should be noted the relatively low temperatures on the surface viewed by the thermal imaging camera shortly before collapse as compared to the surface temperature of the sub-floor exposed to the fire.

Structural Serviceability

Firefighters have expressed concern about the rate of structure's deflection prior to collapse when reporting on experiences upon entering a fire scene and performing life safety and fire extinguishment activities. The firefighters' reports indicate the lightweight wood construction collapses at a quicker rate as compare to floors supported by 2 x 10 in. dimensional lumber.

In addition to the fire resistance rating determined by the Conditions of Acceptance in ASTM E119, a finish rating is typically published for fire resistive assemblies with combustible supports such as the tested samples. The finished rating is defined as the time when the first occurrence of either:

3. Temperature measured on the face of the combustible supports nearest to the fire increases more than 325 ºF; or
4. Average temperature measured on the face of the combustible supports nearest the fire increases more than 250 ºF.

Several fire test standards similar to ASTM E119 such as ISO 834:1 (Fire-resistance tests – Elements of building construction – Part 1: General requirements) define load bearing capacity as the elapsed time that a test sample is able to maintain its ability to support the applied load during the fire test. The ability to support the applied load is determined when both:

3. Deflection exceeds: $\frac{L^2}{400d}$; and
4. When the deflection exceeds $\frac{L}{30}$, the Rate of Deflection exceeds: $\frac{L^2}{9000d}$
   where L is the clear span measured in millimeters and d is the distance from the extreme fiber of the design compression zone to the extreme fiber of the design tensile zone of the structural element as measured in millimeters.

Other significant data obtained during the fire tests included observation of the conditions of the ceiling and floor surfaces, temperatures in the concealed space above the ceiling membrane and deflections of the floor and roof surfaces.

The finish rating and the load bearing capacity of Benchmark assemblies from the AFG sponsored project and the three tested assemblies are summarized in Table 7.

Table 7 - Summary of Significant Events in Addition to ASTM E119 Conditions of Acceptance

Test Assembly No.	Initial falling of ceiling material (More than 1 ft^2) (min:sec)	Average temperature on unexposed surface of ceiling at initial falling (ºF)	Finish rating (min:sec)	Load bearing Capacity (min)

Test Assembly No.	Initial falling of ceiling material (More than 1 ft^2) (min:sec)	Average temperature on unexposed surface of ceiling at initial falling (ºF)	Finish rating (min:sec)	Load bearing Capacity (min)
Benchmark1 [1]	No ceiling	No Ceiling	00:45	18
Benchmark2 [2]	16:00	559	12:15	25
Benchmark3 [3]	16:30	519	10:45	24
Benchmark4 [4]	23:30	605	15:30	45
Benchmark5 [5]	74:00**	1109	74:00**	80
1	17:15	646	13:00	24
2	No ceiling	No ceiling	00:15	10
3	No ceiling	No ceiling	00:30	5

** - plaster ceiling in contact with furnace thermocouples at 51 minutes

Notes:

1 – Benchmark 1 data represents a combustible floor-ceiling assembly of typical unprotected legacy construction (2 x 10) without a ceiling

2 – Benchmark 2 data represents a combustible floor-ceiling assembly of typical modern construction of parallel chord truss with glued connections with a ½ thick regular gypsum board ceiling

3 – Benchmark 3 data represents a combustible floor-ceiling assembly of typical modern construction of parallel chord truss with steel gusset connections with a ½ thick regular gypsum board ceiling

4 – Benchmark 4 data represents a combustible floor-ceiling assembly of typical protected legacy construction (2 x 10) with a ½ inch regular gypsum board ceiling

5 – Benchmark 5 data represents a combustible floor-ceiling assembly of typical protected legacy construction (2 x 10) with a ¾ inch metal lath and plaster ceiling

Summary of Findings

The following summarizes the key findings documented in this report:

From the previous AFG sponsored project, it was determined that the fire containment performance (load bearing capacity) of a combustible floor-ceiling assembly representing typical unprotected legacy construction (2 x 10) without a ceiling was 18 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This was defined as the benchmark (Benchmark 1) fire resistance performance of traditional exposed lumber construction typically found in lowest floor above basement or crawl spaces.

- The fire containment performance of Test Assembly 1 representing modern steel gusset truss construction with a ceiling with penetrations was 6 minutes more than the benchmark performance.
- The fire containment performance of Assembly 2 representing unprotected modern glued truss construction was 8 minutes less than the benchmark performance.
- The fire containment performance of Assembly 3 representing unprotected modern steel gusset construction with stairwell framing was 13 minutes less than the benchmark performance.

From the previous AFG sponsored project, it was determined that the fire containment performance (load bearing capacity) of a combustible floor-ceiling assembly representing typical modern construction of parallel chord truss with glued connections with a ½ thick regular gypsum board ceiling was 25 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This was defined as the benchmark (Benchmark 2) performance of modern glued joint truss construction with a regular gypsum board ceiling typically found in floors above living spaces.

- The fire containment performance of Assembly 2 without the ceiling was 15 minutes less than the benchmark performance.

From the previous AFG sponsored project, it was determined that the fire containment performance (load bearing capacity) of a combustible floor-ceiling assembly representing typical modern construction of parallel chord truss with steel gusset connections with a ½ thick regular gypsum board ceiling was 24 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This was defined as the benchmark (Benchmark 3) performance of modern metal gusset truss construction with a regular gypsum board ceiling typically found in floors above living spaces.

- The fire containment performance of Assembly 3 without the ceiling and framed with a stairwell opening was 19 minutes less than the benchmark performance.

From the previous AFG sponsored project, it was determined that the fire containment performance (load bearing capacity) of a combustible floor-ceiling assembly representing typical protected legacy construction (2 x 10) with a ½ inch regular gypsum board ceiling was 45 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This was defined as the benchmark (Benchmark 4) performance of traditional lumber construction with a regular gypsum board ceiling typically found in floors above living spaces.

- The fire containment performance of Assembly 1 was 21 minutes less than the benchmark performance.
- The fire containment performance of Assembly 2 was 35 minutes less than the benchmark performance.
- The fire containment performance of Assembly 3 was 40 minutes less than the benchmark performance.

From the previous AFG sponsored project, it was determined that the fire containment performance (load bearing capacity) of a combustible floor-ceiling assembly representing typical protected legacy construction (2 x 10) with a ¾ inch metal lath and plaster ceiling was 80 minutes. The time duration was based upon the performance of the assembly when exposed to the time-temperature curve defined in Standard ASTM E119. This was defined as the benchmark (Benchmark 5) performance of traditional lumber construction with a metal lath and plaster ceiling typically found in floors above living spaces.

- The fire containment performance of Assembly 1 was 56 minutes less than the benchmark performance.
- The fire containment performance of Assembly 2 was 70 minutes less than the benchmark performance.
- The fire containment performance of Assembly 3 was 75 minutes less than the benchmark performance.

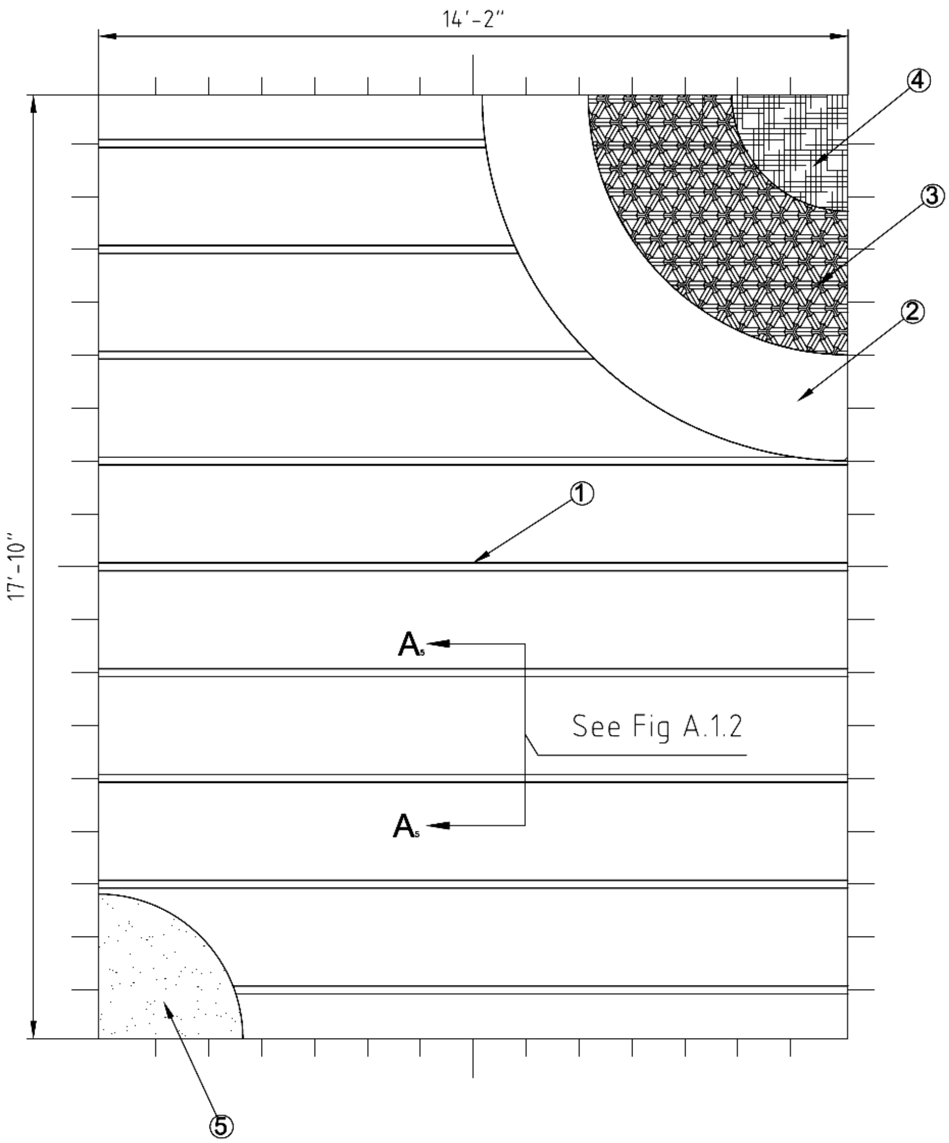
Appendix A – Location of Instrumentation

The location of instrumentation and materials such as thermocouples, deflection transducers, accelerometers, camera locations, joist and truss members, subflooring and finish flooring, and loading conditions are described in this Appendix.

General

Furnace Thermocouples – There were a total of 16 furnace thermocouples space symmetrically throughout the furnace in rows of four.

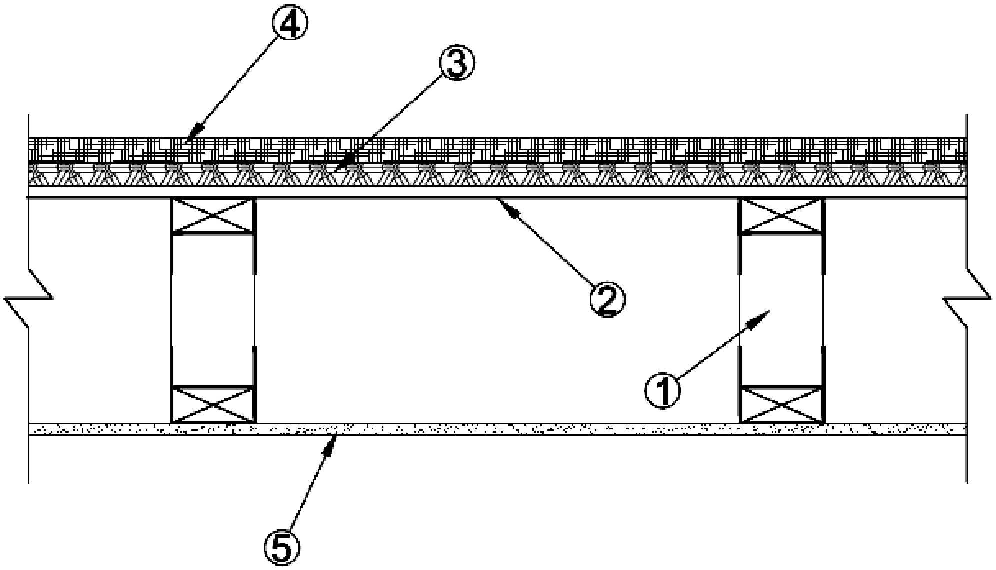
Assembly No. 1:



1) 14 in. wood truss with metal gussets spaced 24 in. O.C. supplied with bottom chord splices with strongback.
2) OSB 23⁄32 in. APA rated sheathing, T&G 48⁄24 span rating.
3) Standard carpet padding.
4) Standard carpeting.
5) ½ in. thick regular gypsum wallboard.

Figure A.1.1 – Construction Layout.

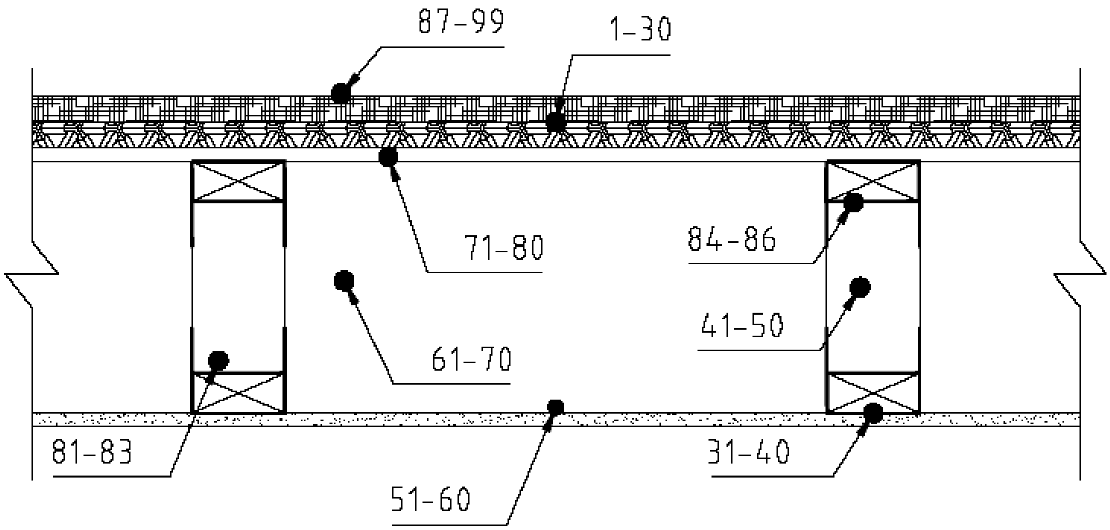
Assembly No. 1



1) 14 in. wood truss with metal gussets spaced 24 in. O.C. supplied with bottom chord splices with strongback.
2) OSB 23⁄32 in. APA rated sheathing, T&G 48⁄24 span rating.
3) Standard carpet padding.
4) Standard carpeting.
5) ½ in. thick regular gypsum wallboard.

Figure A.1.2 – Construction Layout Section A_1-A_1.

Assembly No. 1



TC # LOCATION
1-30 On Carpet padding and subfloor
31-40 On bottom of wood truss (finish rating)
41-50 On side of wood truss at mid depth, facing North
51-60 On back of gypsum panels
61-70 Mid depth
71-80 On bottom of subfloor
81-83 On bottom metal gusset plate, nearest center of assembly , facing north
84-86 On top metal gusset plate, nearest center of assembly, facing north.
87-99 On unexposed surface.

Figure A.1.3 – Thermocouple Locations - Elevation.

Assembly No. 1

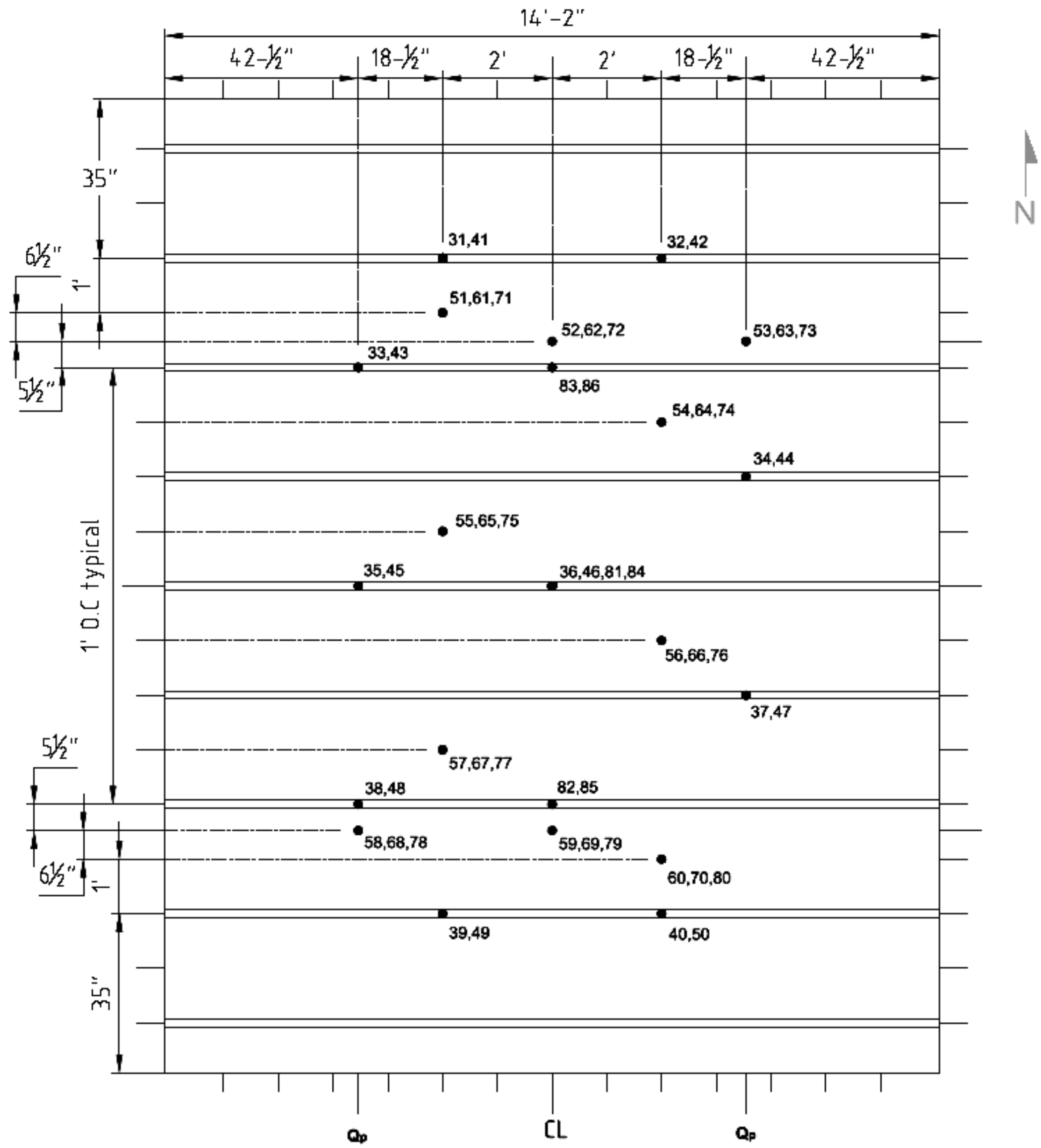


Figure A.1.4 – Thermocouple Locations on Wood Members and Bottom of Subfloor.

Assembly No. 1

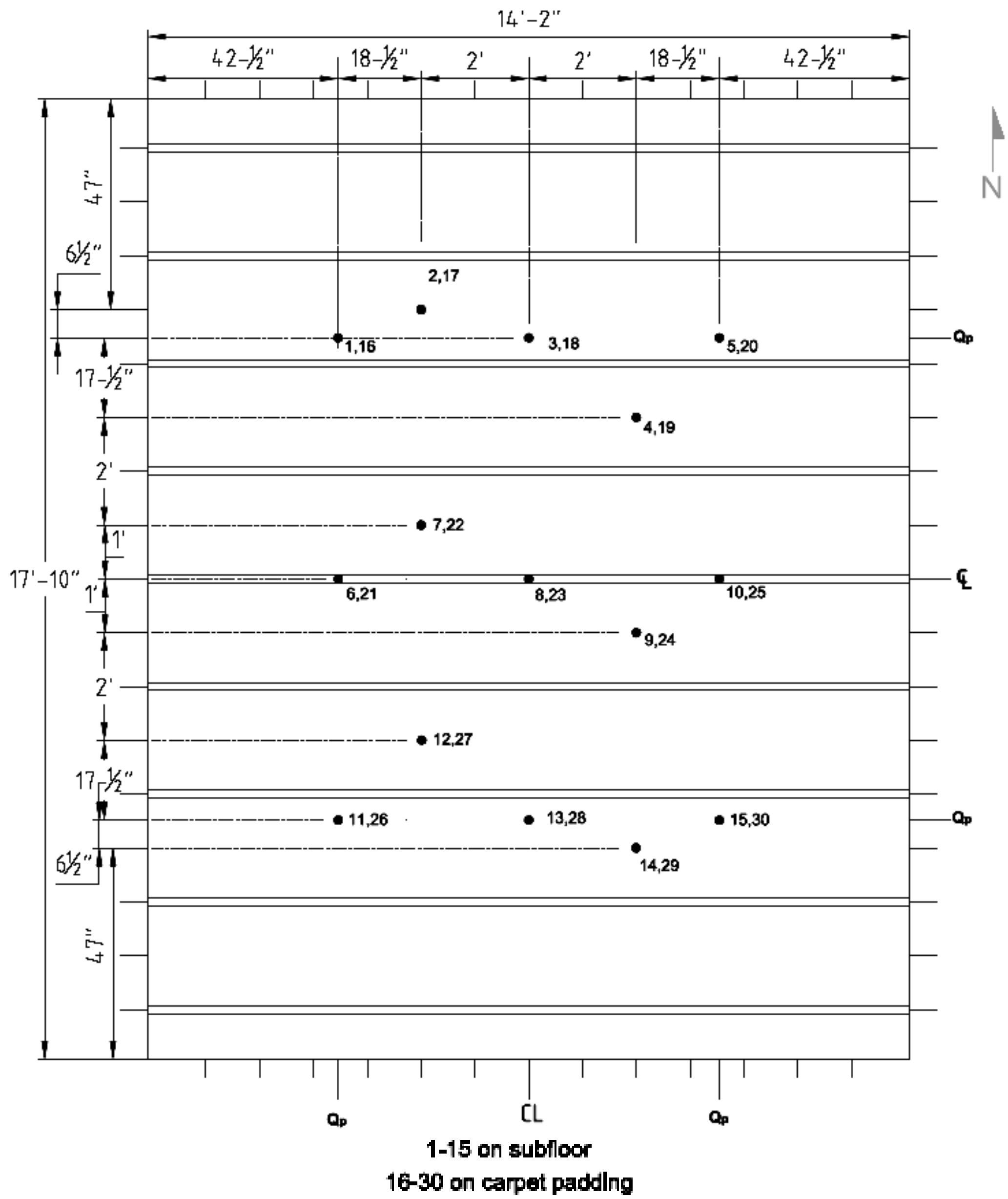


Figure A.1.5 – Thermocouple Locations on Top of Subfloor and Carpet Padding.

Assembly No. 1

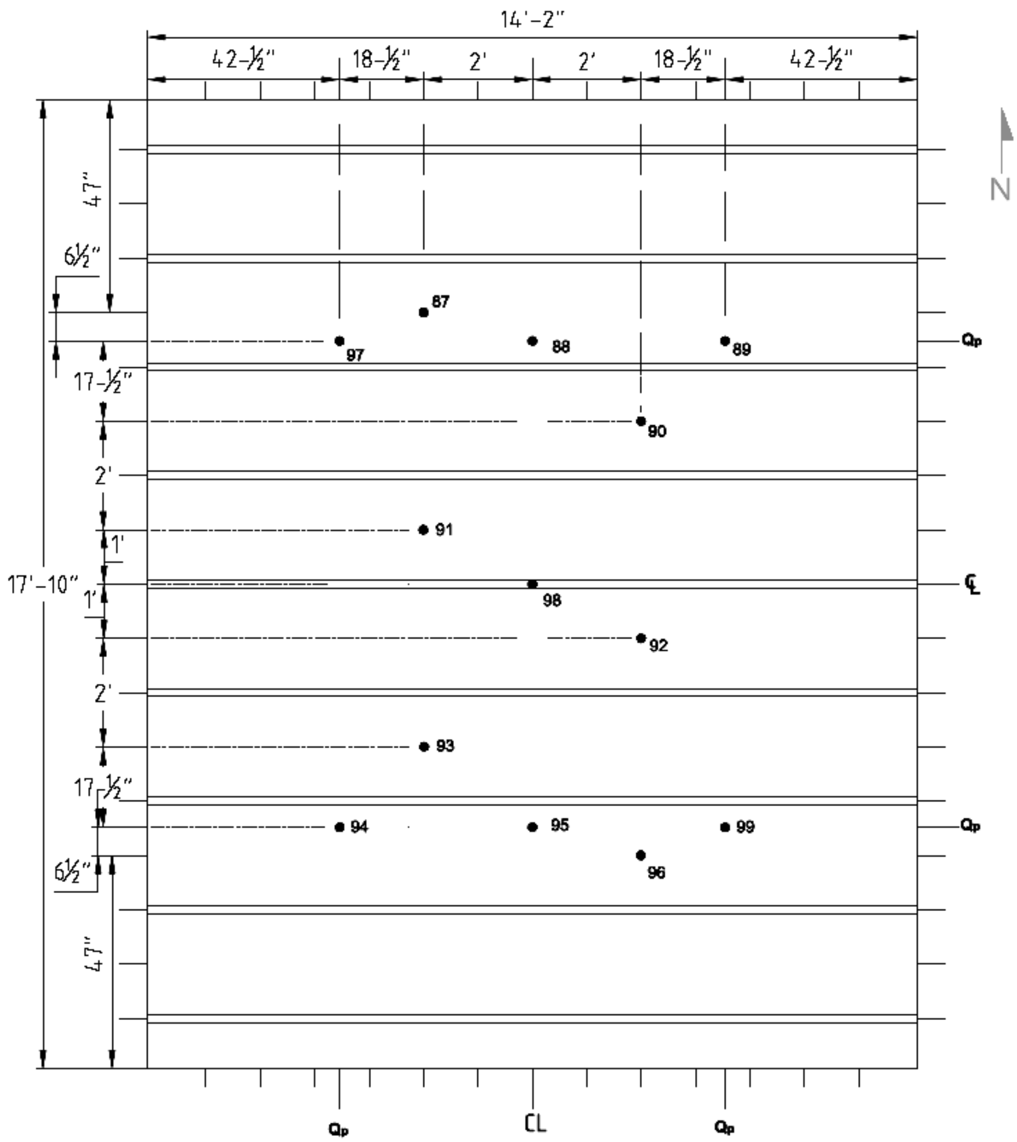
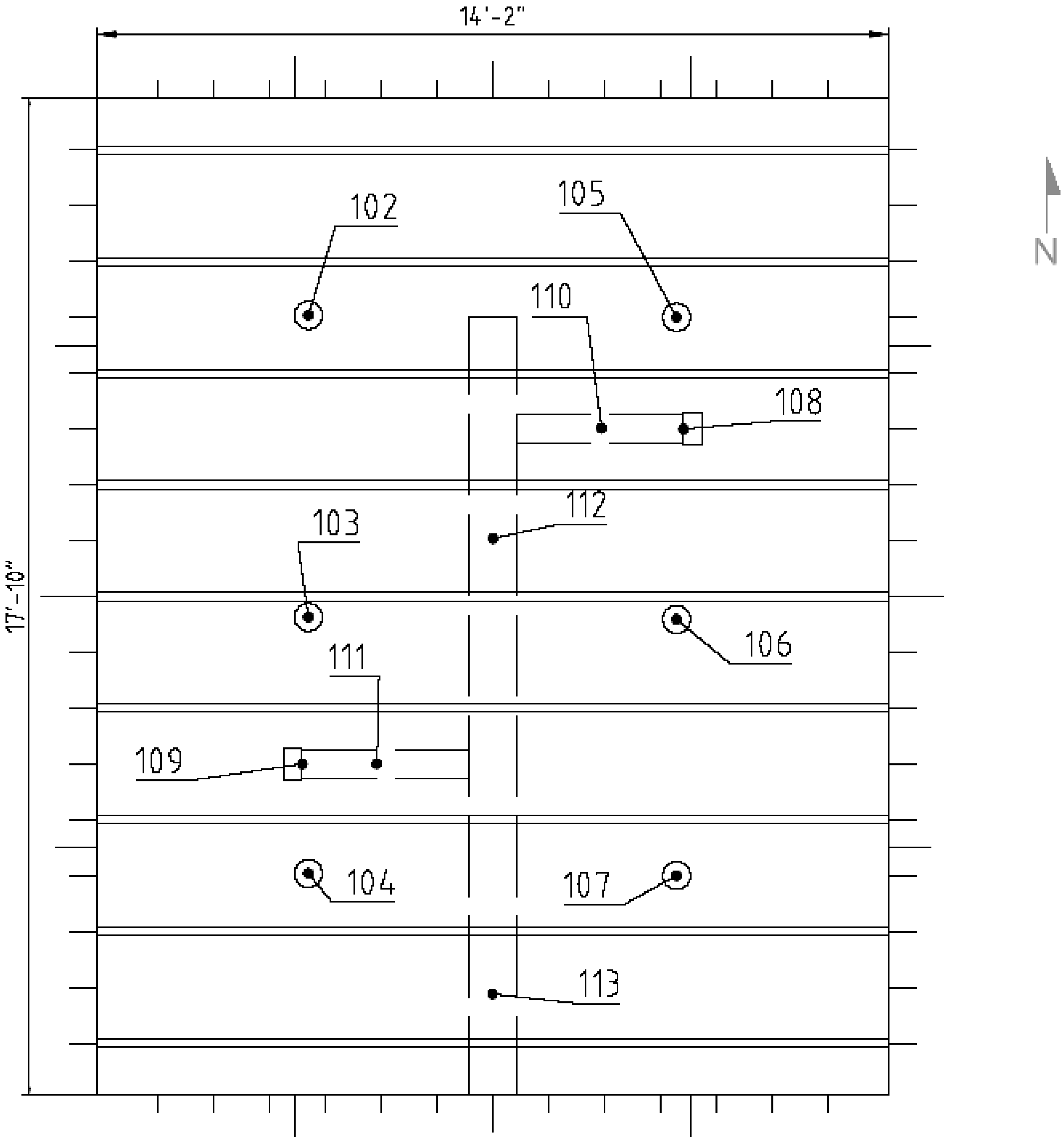


Figure A.1.6 – Thermocouple Locations on Unexposed Surface.

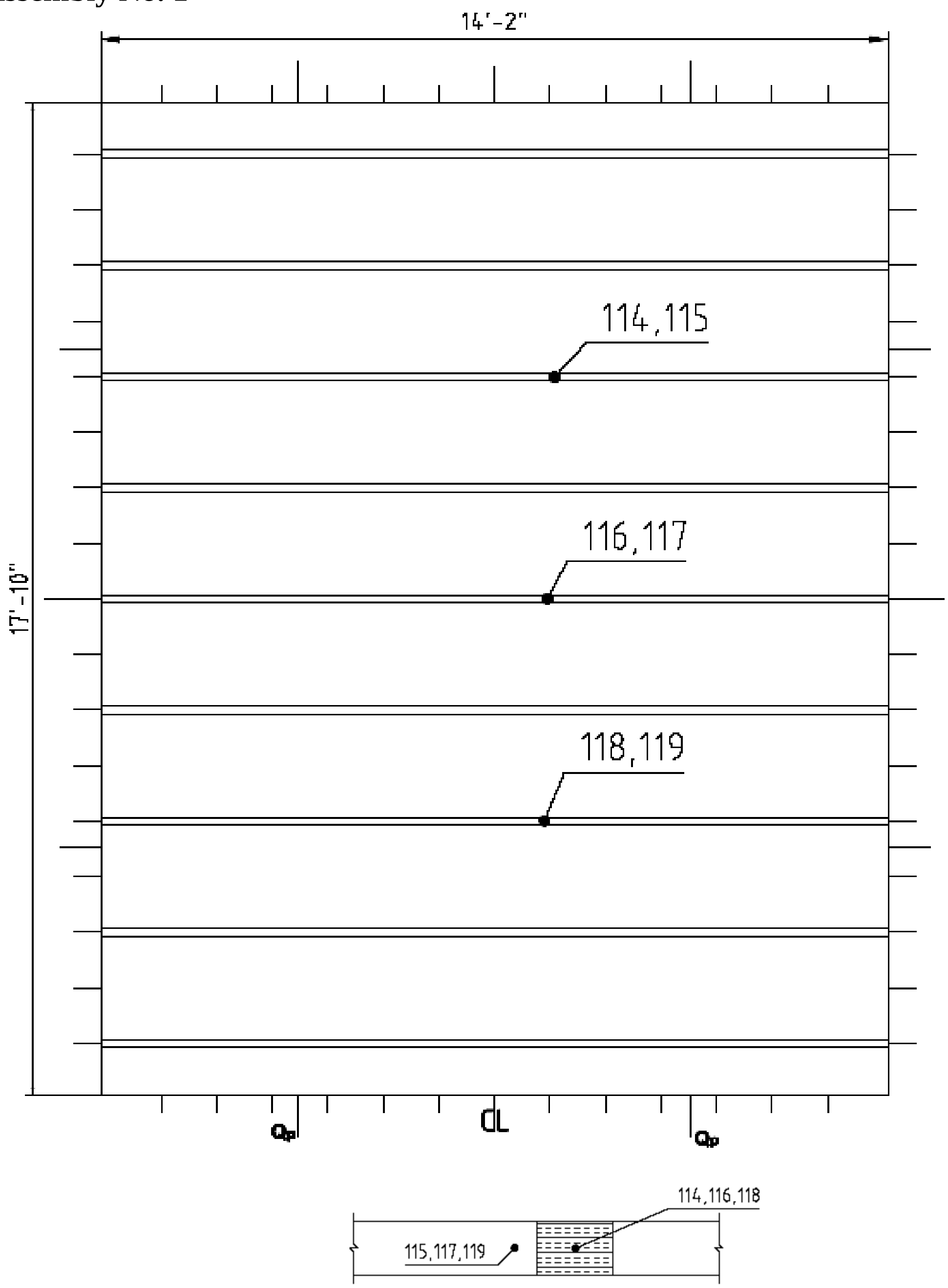
Assembly No. 1



102 - 107 - On top of can lights over can light venting
108 - 109 - On top fo flexible duct right before junction of supply register inlet.
110 - 111 - On top of flexible duct at mid span
112 - 113 - On top of ridged supply duct.

Figure A.1.7 – Thermocouple Locations on Ducts and Can Lights

Assembly No. 1



TC. No.	Location
114,116,118	Behind metal gusset splice plate on bottom of truss.
115,117,119	On 2x4 member, 2 in. west of edge of bottom metal gusset splice plate.

Note: All thermocouples facing north.

Figure A.1.8 – Thermocouple Locations on Metal Gusset Plates

Assembly No. 1

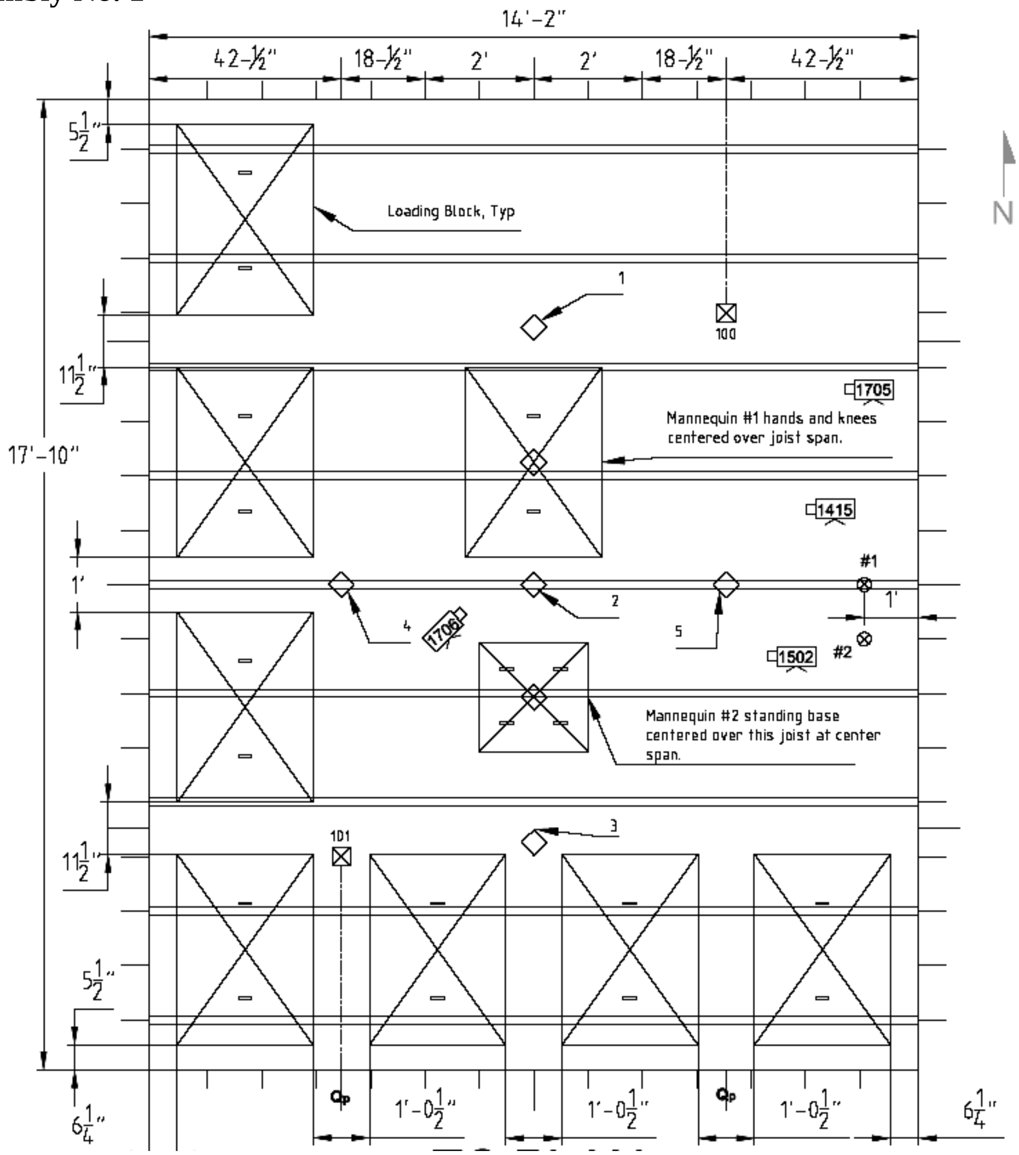


Figure A.1.9 – Loading and Instrumentation Layout (See Figure A.1.10).

Assembly No. 1

Deflection Transducers: ◇

1 - Along E-W Centerline, North Quarter-point.
2 - Along E-W Centerline, Center-point.
3 - Along E-W Centerline, South Quarter-point.
4 - Along N-S Centerline, West Quarter-point.
5 - Along N-S Centerline, East Quarter-point.

Accelerometers: ⊗

1- Over Joist, 12 in. from East edge of assembly.
2- Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 - Mannequin No. 1 (Hands & Knees)
2 - Mannequin No. 2 (Standing)

Video Camera Recordings:(Not Shown)

Ch 1409 - Floor level view from Northeast corner
Ch 1411 - IR camera from curing cell roof east center
Ch 1412 - Furnace camera From Northwest corner
Ch 1416 - Overhead from East center of assembly
Ch 1413 - Overhead From South center of assembly
Ch 1503 - Overhead from West center of assembly

Video Camera Recordings:

Ch 1415 - Internal camera East (installed in joist cavity facing West - under kneeling mannequin #1 Includes canlight view.
Ch 1502 - Internal camera East (installed in joist cavity facing west - under standing mannequin #2
Ch 1705 - Internal camera installed in joist cavity facing West to ovtian supplyu register view.
Ch 1706 - Internal camera install in joist cavity fasing East to obtain splice detail.

Plate thermocouples: ⊠

100 - In N.E. quadrant 100 mm below ceiling membrane.
101 - In S.W. quadrant 100 mm below ceiling membrane.

Furnace Presure Probes: (Not shown)

1 - located near plate thermocouple No. 100
2 - located near plate thermocouple No. 101

Oxygen Content: (Not Shown)

located in E exaust duct.

Figure A.1.10 – Loading and Instrumentation Key

Assembly No. 2

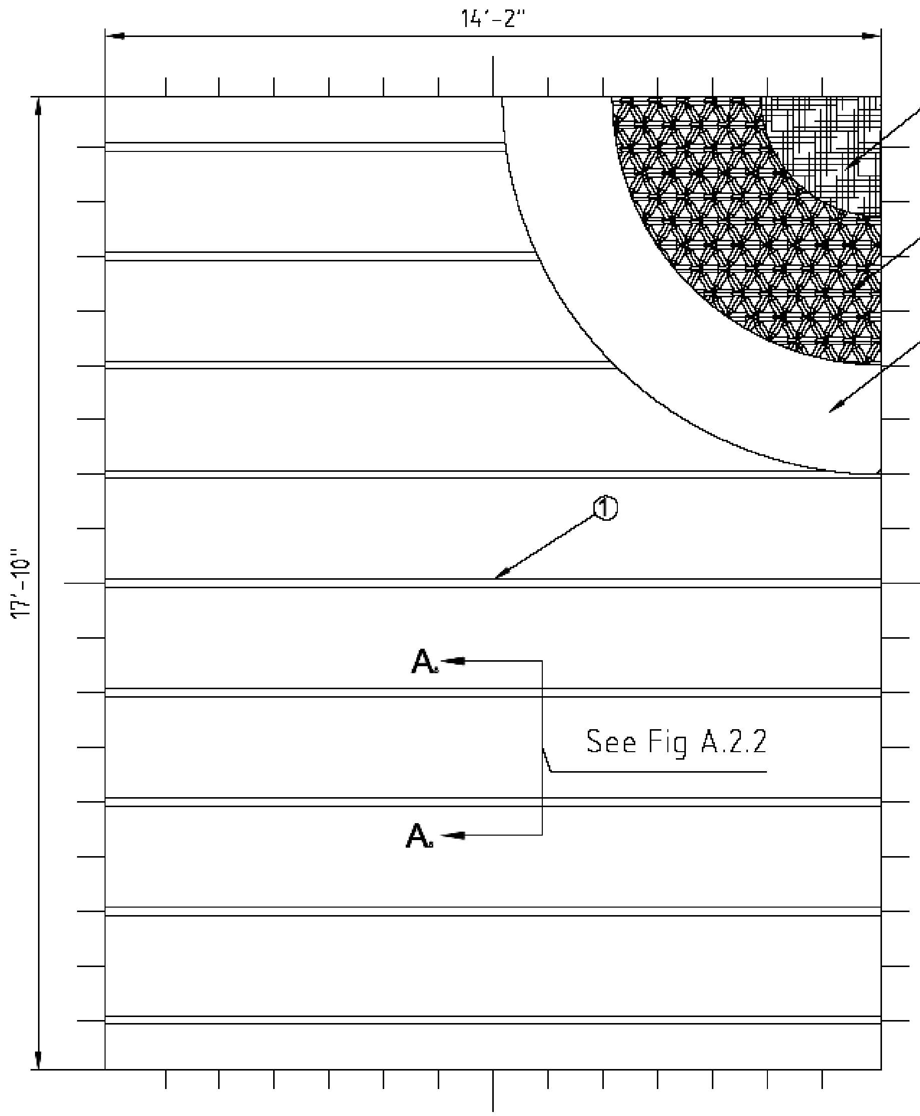
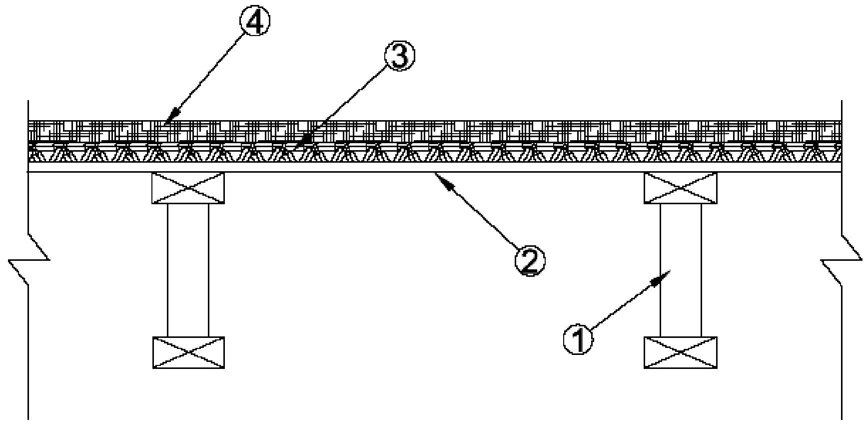


Figure A.2.1 – Construction Layout

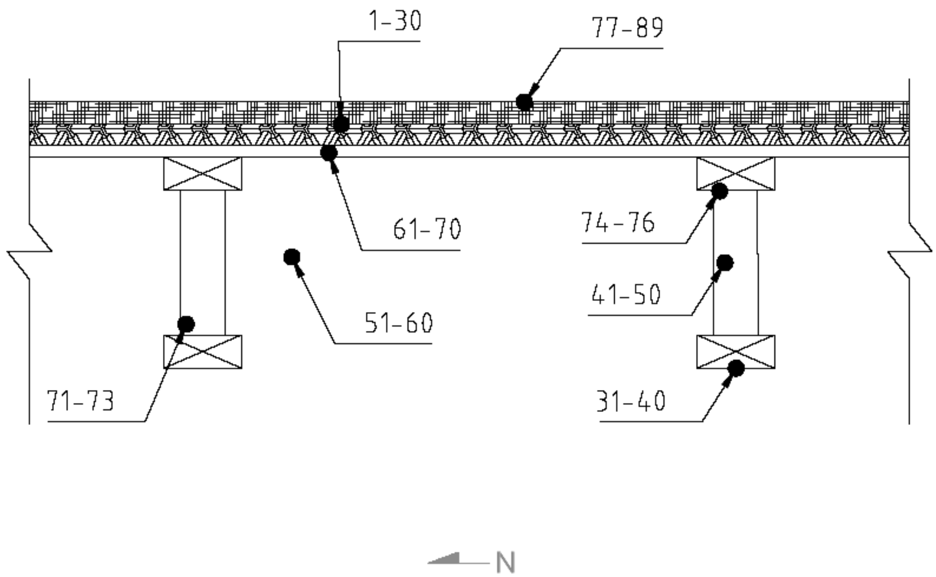
Assembly No. 2



1) 14 in. Deep wood truss with glued finger joints spaced 24 in. O.C.
2) OSB 23⁄32 in. APA rated sheathing, T&G 48⁄24 span rating.
3) Standard carpet padding.
4) Standard carpeting.

Figure A.2.2 – Construction Layout Section A_2-A_2.

Assembly No. 2



TC # LOCATION
1-30 On subfloor and carpet padding
31-40 On bottom of wood truss (finish rating)
41-50 On side of wood truss at mid depth, facing North
51-60 Mid depth
61-70 On bottom of subfloor
71-73 On glued finger joint, nearest center of assembly , facing north
74-76 On glued finger joint, nearest center of assembly, facing north
77-89 On unexposed surface

Figure A.2.3 – Thermocouple Locations - Elevation.

Assembly No. 2

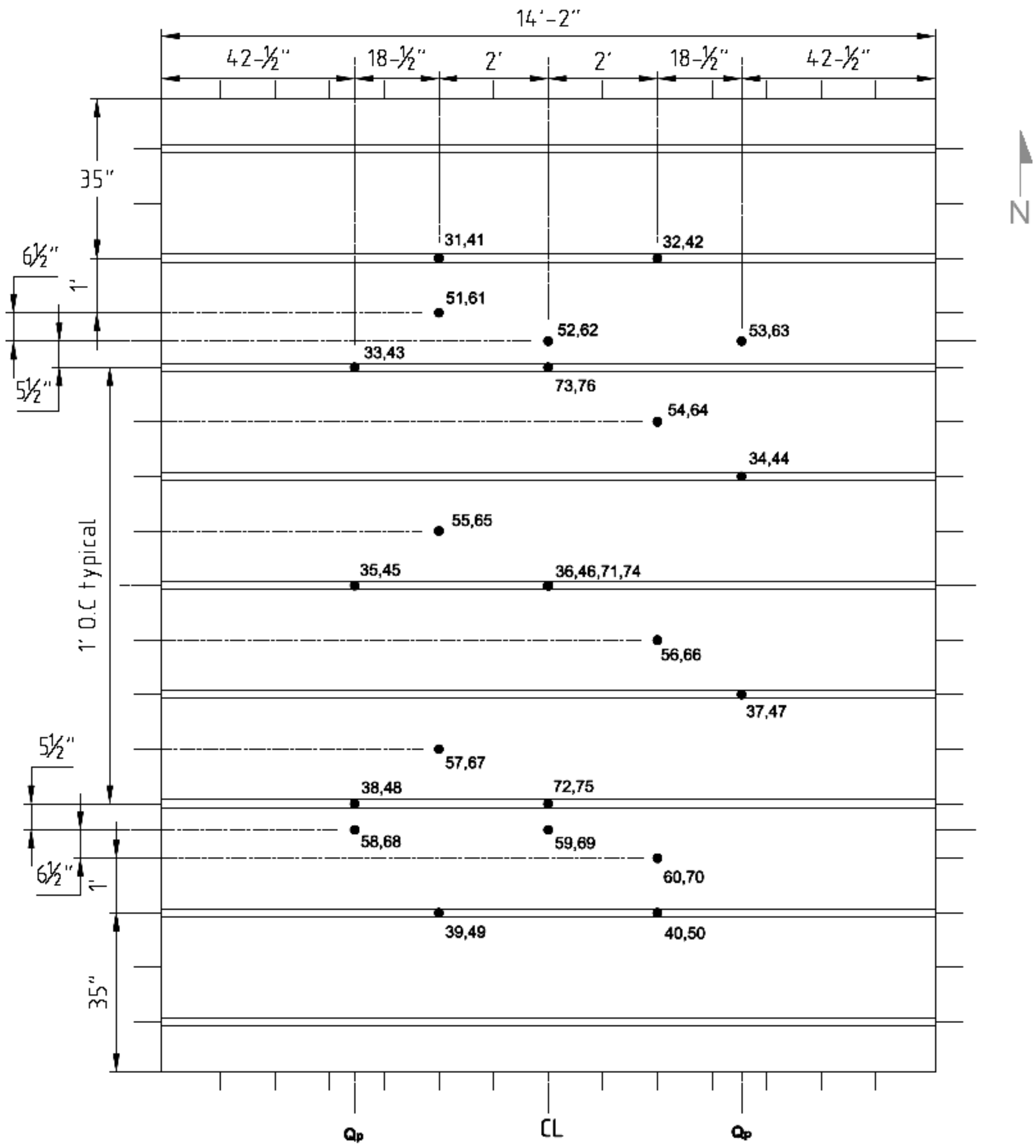


Figure A.2.4 – Thermocouple Locations on Wood Members and Bottom of Subfloor.

Assembly No. 2

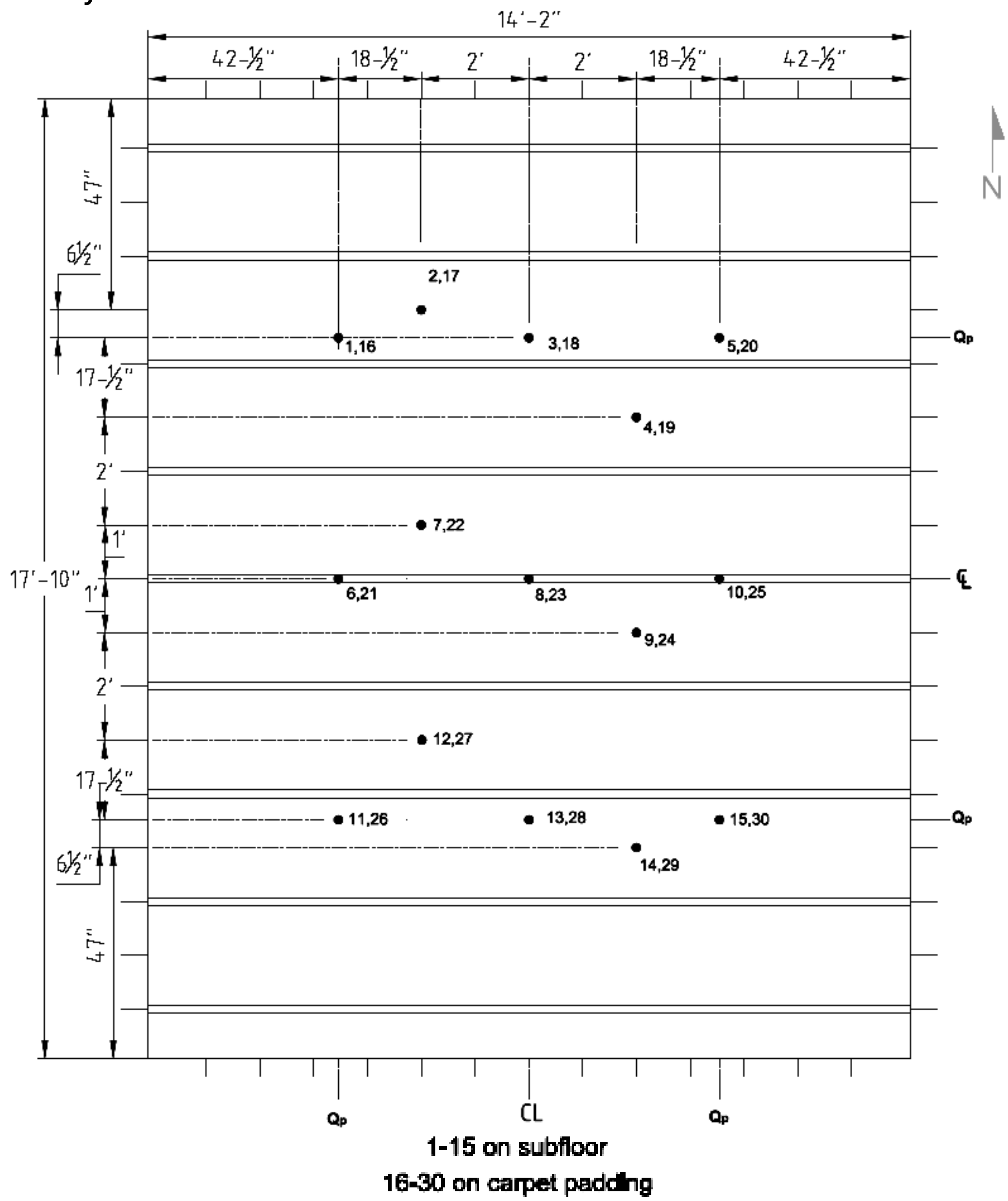


Figure A.2.5 – Thermocouple Locations on Subfloor and Carpet Padding.

Assembly No. 2

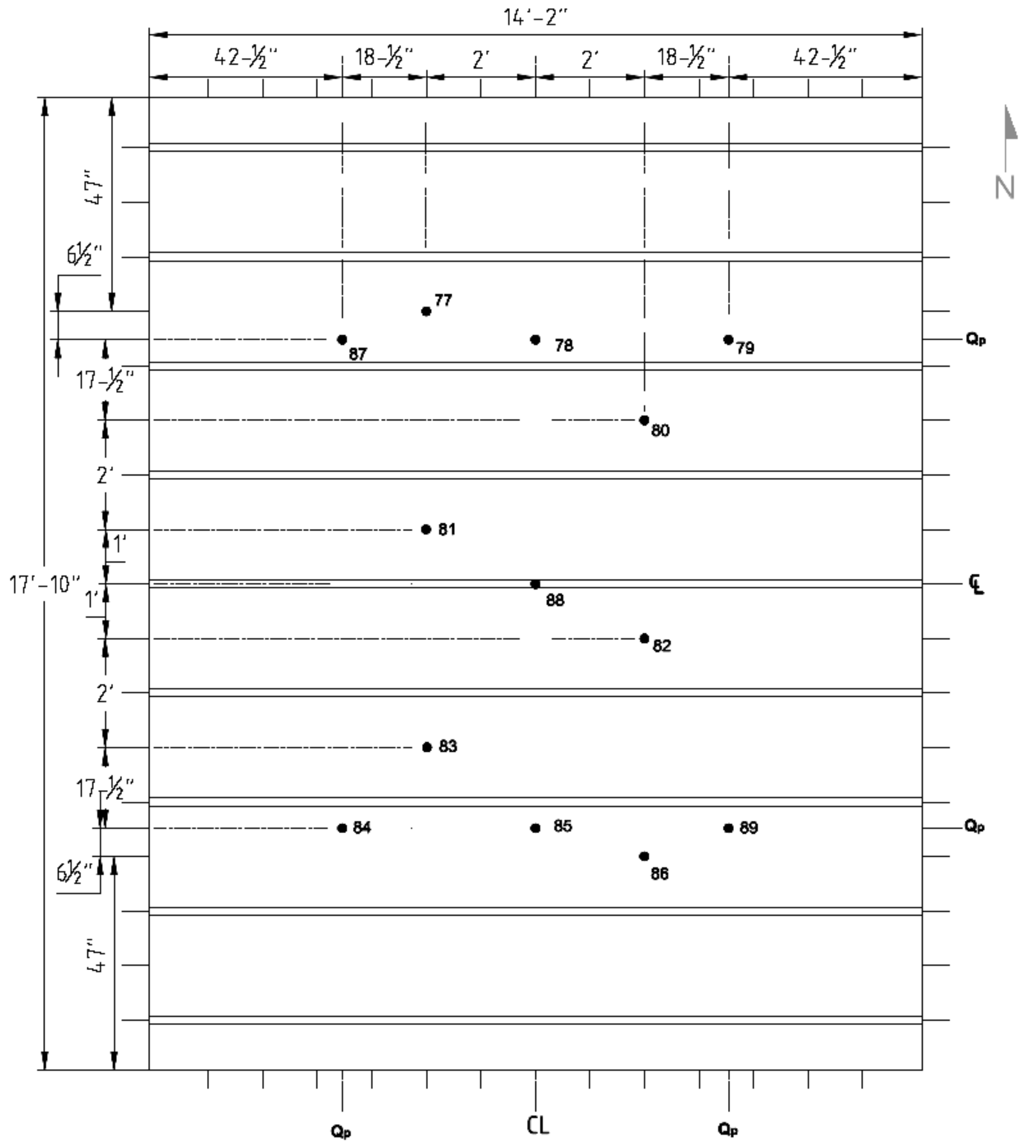


Figure A.2.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 2

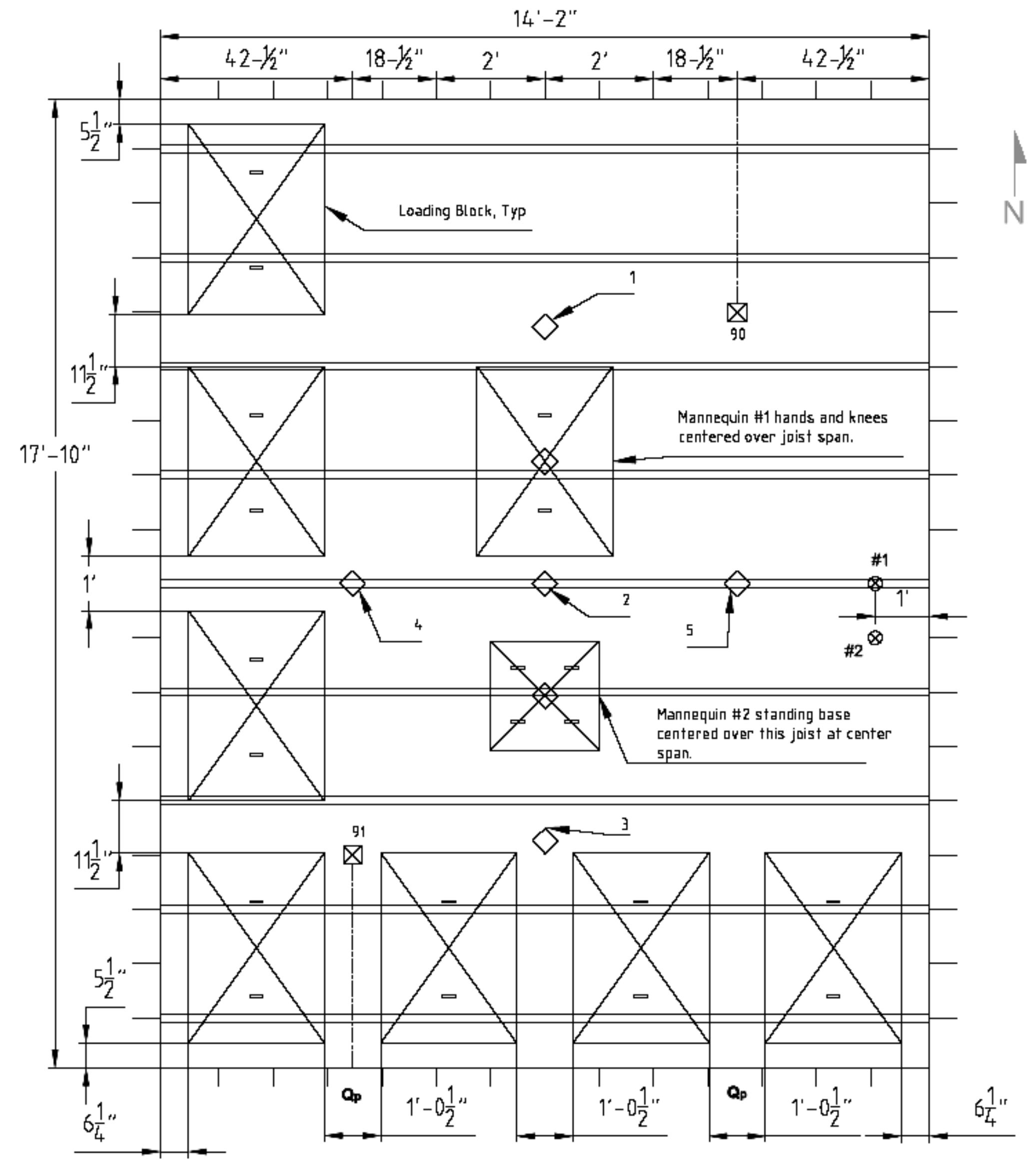


Figure A.2.7 – Loading and Instrumentation Layout (See Figure A.2.8).

Assembly No. 2

Deflection Transducers: ◇

1 - Along E-W Centerline, North Quarter-point.
2 - Along E-W Centerline, Center-point.
3 - Along E-W Centerline, South Quarter-point.
4 - Along N-S Centerline, West Quarter-point.
5 - Along N-S Centerline, East Quarter-point.

Accelerometers: ⊗

1- Over Joist, 12 in. from East edge of assembly.
2- Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 - Mannequin No. 1 (Hands & Knees)
2 - Mannequin No. 2 (Standing)

Video Camera Recordings:(Not Shown)

Channel 1409 - floor level view from northeast corner
Channel 1411 - IR camera from curing cell roof east center
Channel 1412 - furnace camera from northwest corner
Channel 1416 - overhead from east center of assembly
Channel 1413 - overhead from south center of assembly
Channel 1503 - overhead from west center of assembly

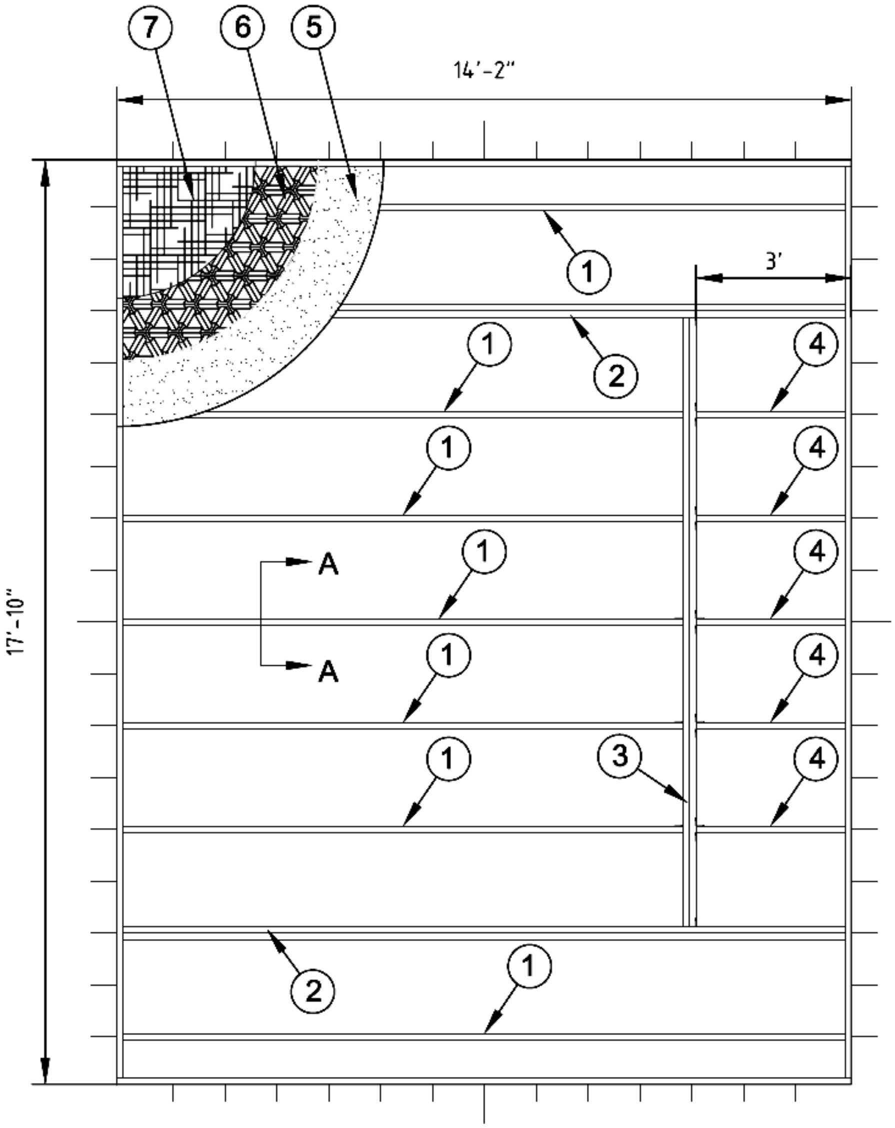
Plate Thermocouples: ⊠
90 - in northeast quadrant 100mm below subfloor surface
91 - in southwest quadrant 100mm below subfloor surface

Furnace Pressure Probes: (Not Shown)
1 - located near plate thermocouple No. 100
2 - located near plate thermocouple No. 101

Oxygen Content : (Not Shown)
located in E exhaust duct.

Figure A.2.8 – Loading and Instrumentation Key

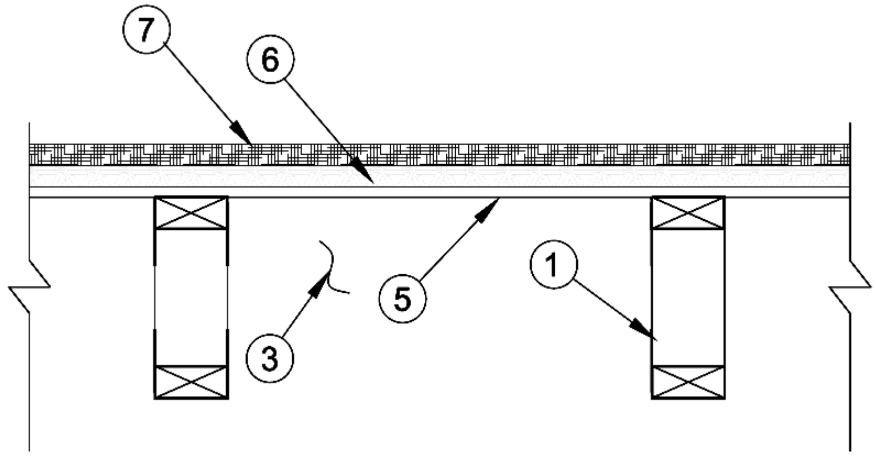
Assembly No. 3



1) 14 in. deep wood truss with metal gussets spaced 24 in. O.C.
2) 14 in. deep wood truss girders
3) 14 in. deep LVL header.
4) 14 in. deep engineered I-Joist spaced 24 in. O.C.
5) OSB $^{23}/_{32}$ in. APA rated sheathing, T& G $^{48}/_{24}$ span rating.
6) Standard carpet padding
7) Standard carpeting.

Figure A.3.1 – Construction Layout.

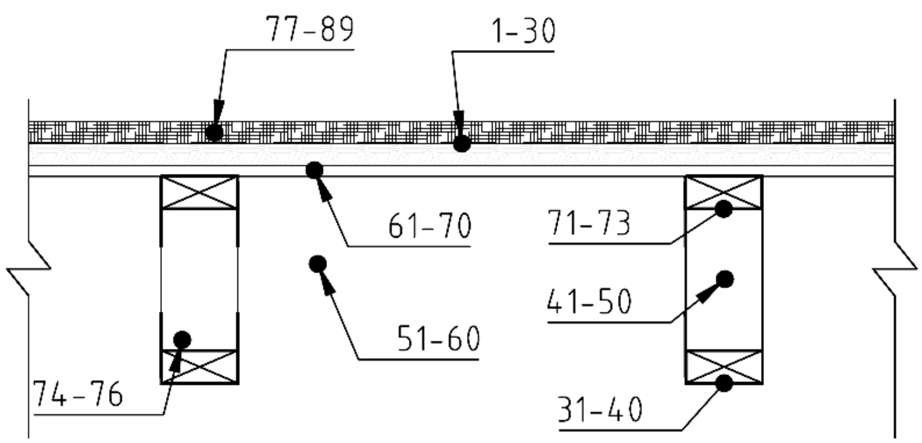
Assembly No. 3



1) 14 in. deep wood truss with metal gusets spaced 24 in. O.C.
2) 14 in. deep wood truss girders
3) 14 in. deep LVL header.
4) 14 in. deep engineered I-Joist spaced 24 in. O.C.
5) OSB $^{23}/_{32}$ in. APA rated sheathing, T& G $^{48}/_{24}$ span rating.
6) Standard carpet padding
7) Standard carpeting.

Figure A.3.2 – Construction Layout Section A_3-A_3.

Assembly No. 3



TC #	Loctation
1-30	On carpet padding and subfloor
31-40	On bottom of wood mebers (finish rating)
41-50	On side of wood truss at mid depth, facing North
51-60	Mid depth
61-70	On bottom of subfloor
71-73	On top metal gusset plate, nearest center of assembly, facing North
74-76	On bottom of metal gusset plate, nearest center of assembly facing North
77-89	On unexpsoed surface.
90-97	Not show on this drawing

Figure A.3.3 – Thermocouple Locations - Elevation.

Assembly No. 3

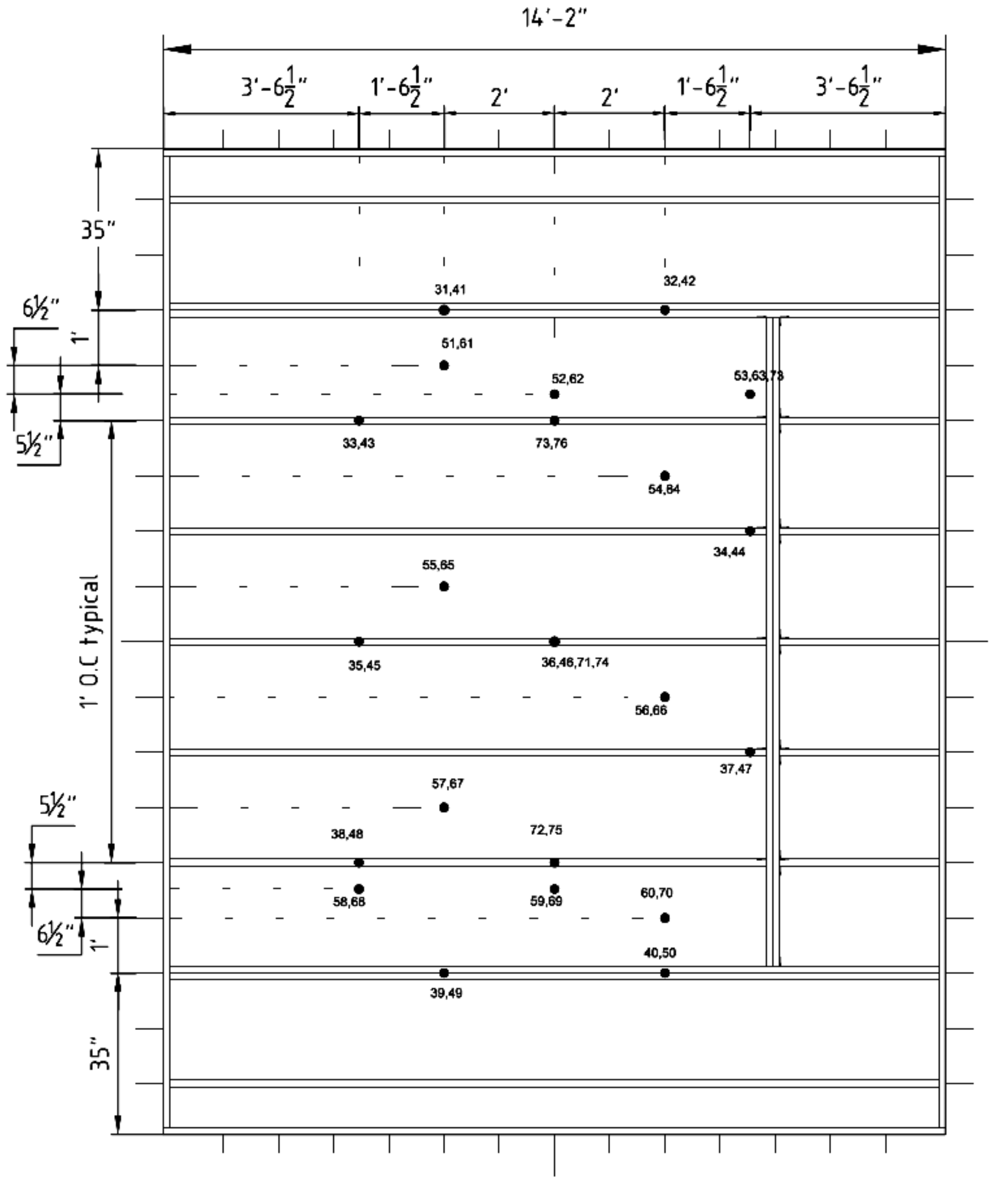


Figure A.3.4 – Thermocouple Locations on Wood Member and Bottom of Subfloor.

Assembly No. 3

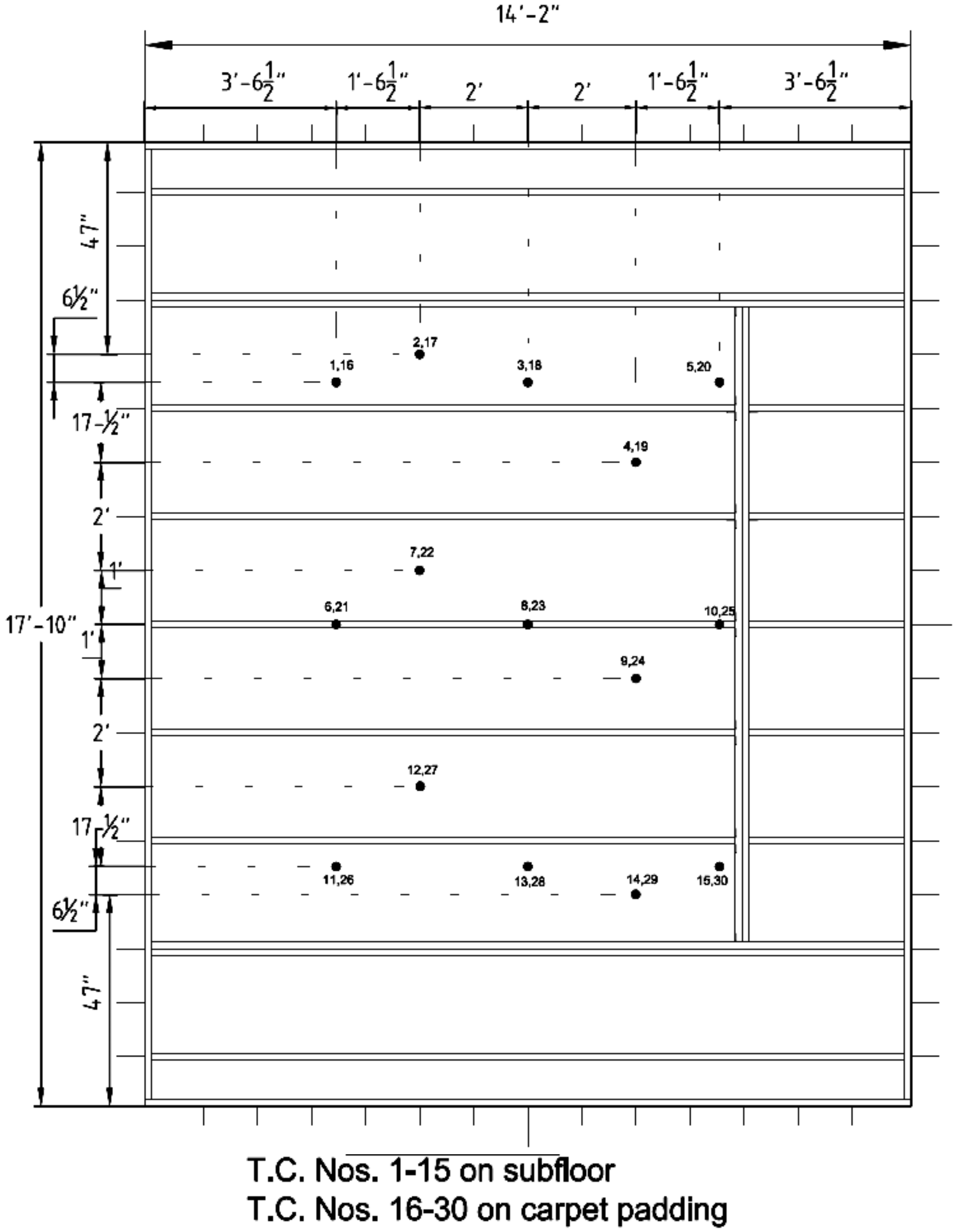


Figure A.3.5 – Thermocouple Locations on Subfloor and on Carpet Padding.

Assembly No. 3

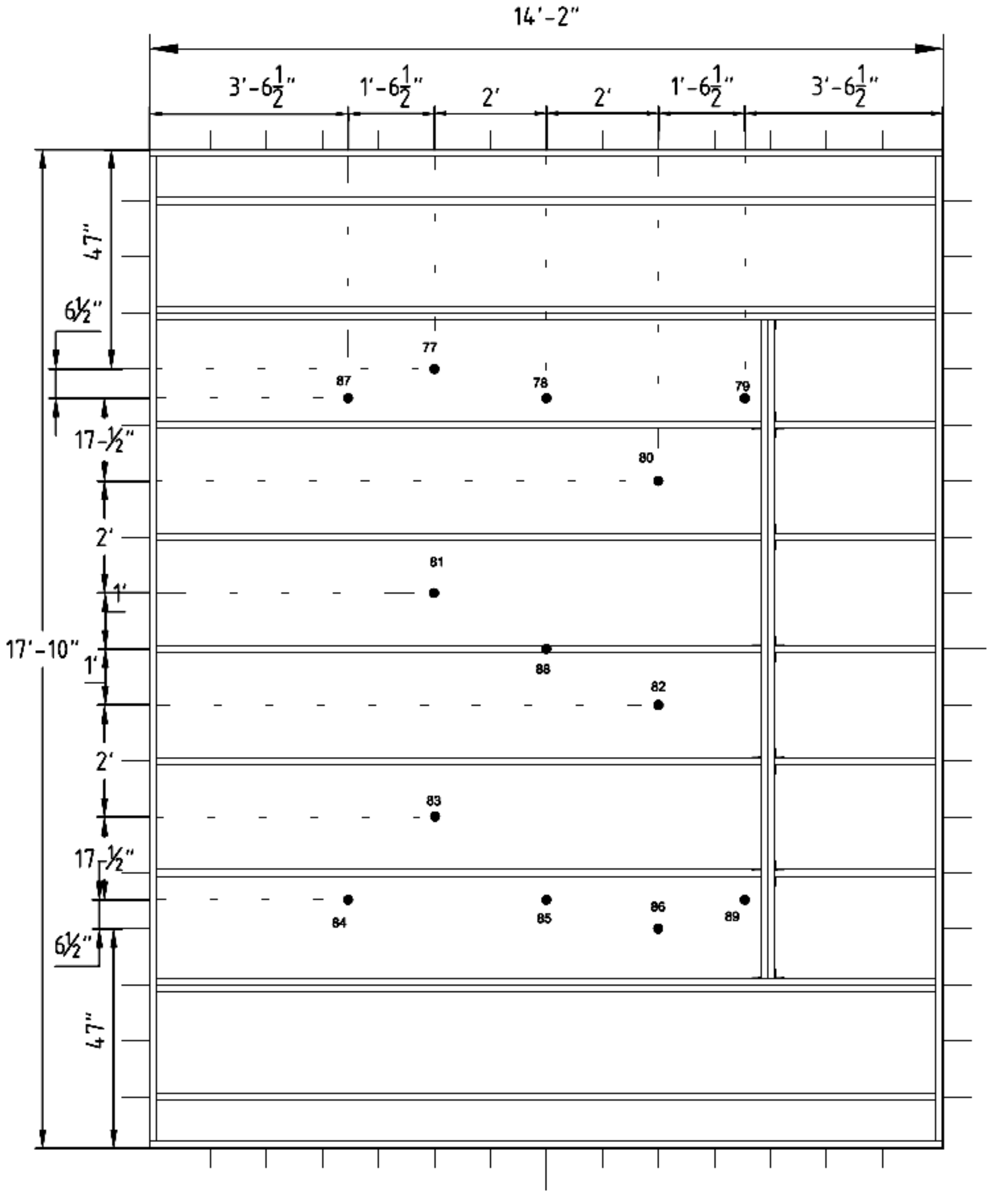


Figure A.3.6 – Thermocouple Locations on Unexposed Surface.

Assembly No. 3

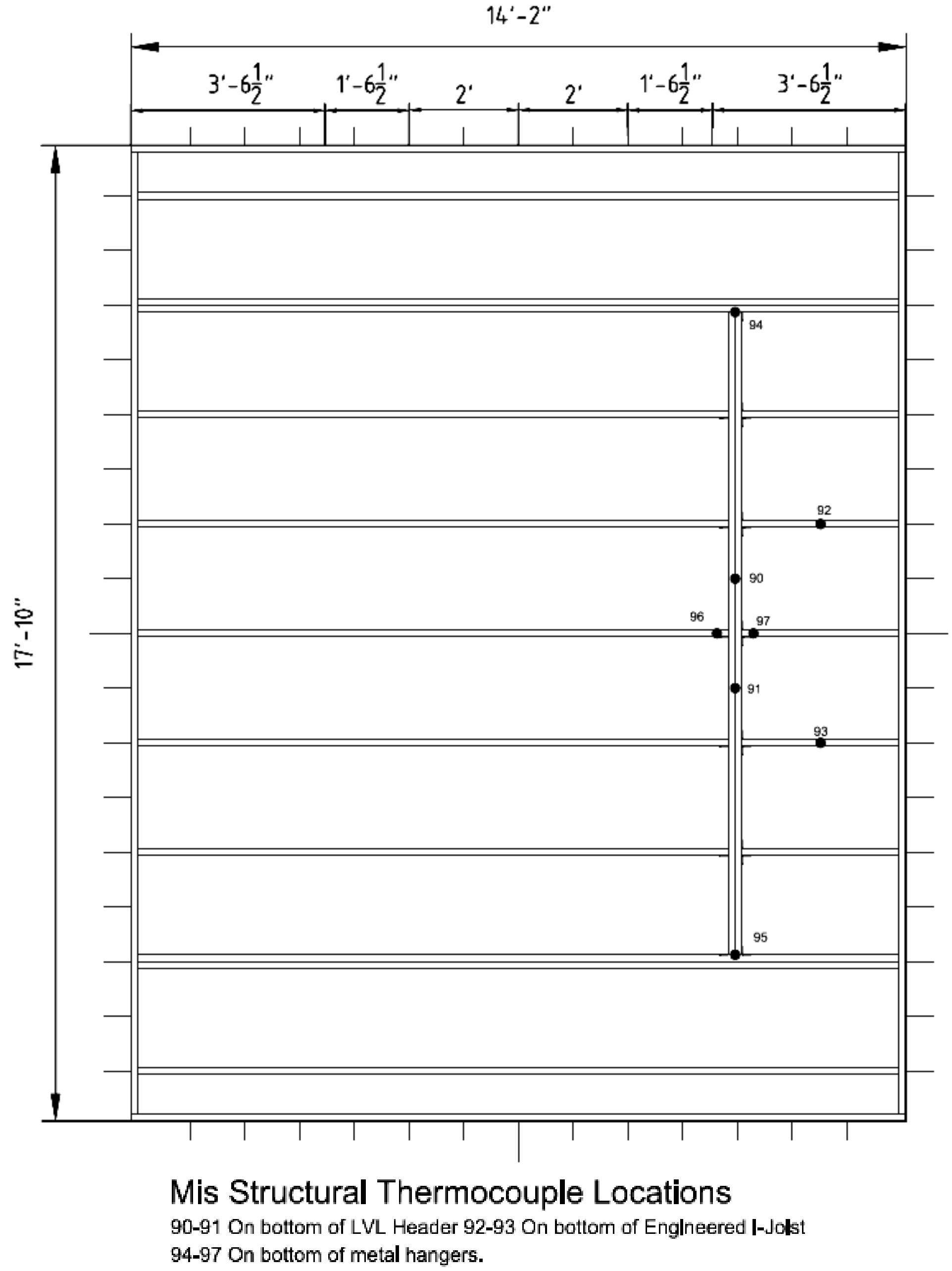


Figure A.3.7 –Thermocouple Locations on LVL Assembly and Metal Connectors.

Assembly No. 3

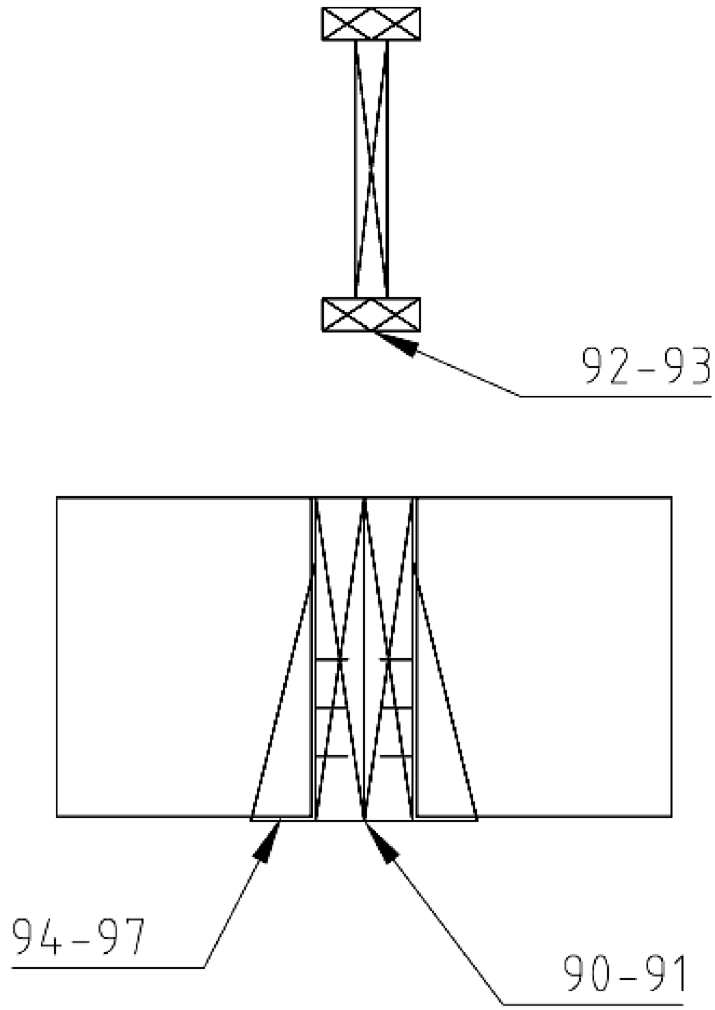


Figure A.3.8 – Elevation of Thermocouple Locations on LVL Assembly and Metal Connectors.

Assembly No. 3

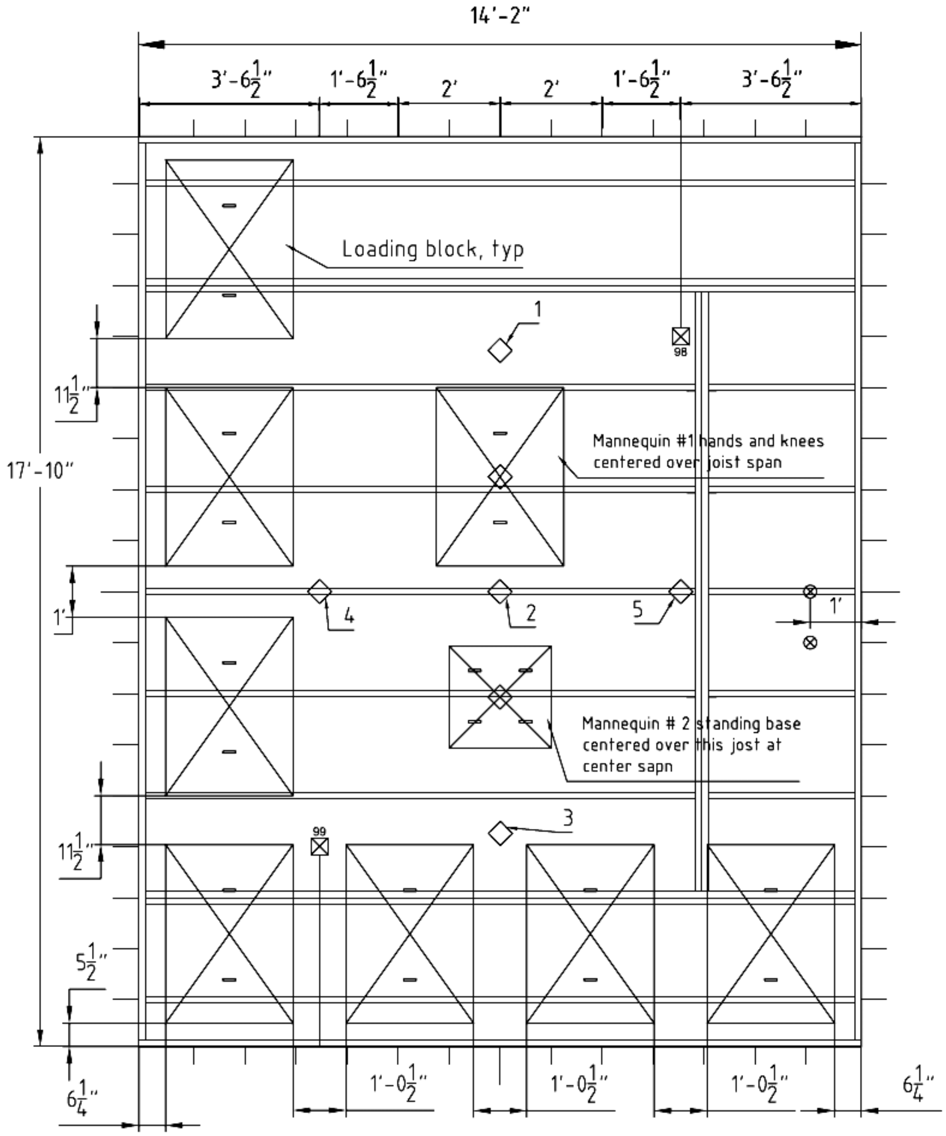


Figure A.3.9 – Loading and Instrumentation Layout (See Figure A.3.10).

Assembly No. 3

Thermocouples:
Thermocouple No. 98 - Plate Thermocouple Centered Between Joist Along Quarter-point, Bottom Surface of Plate Thmermocouple 100 mm From Bottom Surface of Flooring.

Thermocouple No. 99 - Plate Thermocouple Centered Between Joist Along Quarter-point, Bottom Surface of Plate Thmermocouple 100 mm From Bottom Surface of Flooring.

Deflection Transducers:

1 - Along E-W Centerline, North Quarter-point.
2 - Along E-W Centerline, Center-point.
3 - Along E-W Centerline, South Quarter-point.
4 - Along N-S Centerline, West Quarter-point.
5 - Along N-S Centerline, East Quarter-point.

Accelerometers:

1- Over Joist, 12 in. from East edge of assembly.
2- Over Center of Span, 12 in. from East edge of assembly.

Audio Recordings: (Not Shown)

1 - Mannequin No. 1 (Hands & Knees)
2 - Mannequin No. 2 (Standing)

Video Camera Recordings:(Not Shown)

Channel 1409 - floor level view from northeast corner
Channel 1411 - IR camera from curing cell roof east center
Channel 1412 - furnace camera from northwest corner
Channel 1416 - overhead from east center of assembly
Channel 1413 - overhead from south center of assembly
Channel 1503 - overhead from west center of assembly

Furnace Pressure Probes: (Not Shown)
1 - located near plate thermocouple No. 98
2 - located near plate thermocouple No. 99

Oxygen Content : (Not Shown)
located in E exhaust duct.

Figure A.3.10 – Loading and Instrumentation Key

RECOMMENDED CHANGES TO THE 2018 INTERNATIONAL RESIDENTIAL CODE
POSITION OF THE HOME BUILDERS ASSOCIATION OF GREATER KANSAS CITY

Position paper prepared by the Codes Task Force
George Schluter, Chairman

Endorsed and supported by the Board of Directors of KC HBA
Gary Kerns, President

The following commentary regarding the adoption of the 2018 IRC has been prepared by the KC HBA to provide various cities and counties in the metropolitan area our position on specific sections of the IRC as they consider the adoption of the new code for residential construction.

We are supportive of adopting the 2018 IRC with the outlined amendments. There may be some amendments that would only apply to a specific city or county, and we will be glad to discuss these on an individual basis and submit our recommendations.

In this recommendation we have used some abbreviations for organizations. They are as follows:

ICC—International Code Council
JOBO—Johnson County Building Officials
NFPA—National Fire Presentation Association
FEMA—Federal Emergency Management Agency
IRC—International Residential Code
NAHB—National Association of Home Builders
KC HBA & HBA—Home Builders Association of Greater Kansas City
APA—American Wood Council

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Local Security Ordinances

During the time frame of 2009-11 a group of Overland Park police officers developed a proposed change to city ordinances regarding security in newly constructed homes. This model ordinance was adopted by some of cities in the metropolitan area. The ordinance deals with many areas in the home but the primary emphasis was on securing the entrance doors to the residences.

This same group of officers developed what we believe is one of the best new innovative products to enter the home security market—"jambrace". This product has become a standard product used by most area millwork companies in the metro market when they assemble exterior door units. Most millwork companies tell us that they use it on ALL the exterior door assemblies.

During the cycle of the 2012 IRC code adoption process this model language was submitted by the police officers to the ICC for adoption in the IRC. It was heard by the IRC committee in the spring of 2012 and rejected by the committee by a unanimous vote. The proponents did not submit public comment and it was defeated at the fall 2012 Public Comment hearing/vote. Since that time, no one as far as we are aware has put forth any effort to resubmit similar code change language. There were no proposals made during the 2015 or 2018 IRC/IBC code hearing cycles.

The KC HBA believes that a few areas need to be amended to current language in the ordinances. These include:

1. Remove the requirement that exterior lights beside or over exterior doors need to be sealed fixtures or higher than 8 feet above the walking surface.

   Reasoning: We have many complaints from home owners that they cannot easily change burned out bulbs, and what happens is that the home owner leaves the fixture with a burned-out bulb providing no light protection. We realize that LED bulbs would go a long way to solving this problem, but home owners do NOT like LED, they want the warmth that is provided by incandescent bulbs. This was verified by checking with several large light fixture companies that supply our new home market; they tell us that over 90% of the bulbs that they ship with new exterior fixtures are incandescent. We feel that it is better to provide light at entry doors rather than have none due to burned out bulbs.

2. Remove the requirement that deadbolt locks have a specific diameter and hardness of the bolts used to mount the two sides of deadbolt locks to the door. Allow the use of both ANSI Grade 2 and 3 deadbolts (residential) and Grade 1(commercial).

   Reasoning: We have reviewed this requirement and cannot find that the performance of the lock will be compromised by using bolts that are of slightly smaller diameter. When a lock is securely installed in a door, it is next to impossible to get some form of pry bar into the area between the lock surface and door surface to attempt to pry the lock away from the door and break it. While the additional cost may seem small, each time we increase building costs we eliminate another group of potential homeowners because they cannot afford a new, safer and more energy efficient home so they have to turn to older used homes. Also, you need to consider that most entry doors, especially on the front, have either glass in the door or in sidelights, which can easily be broken and an intruder could then just reach in and unlock the deadbolt.

3. Remove the requirement for either a wrap-around metal plate around the lock or the requirement that a metal protective "L" strike plate be placed on the door edge where the deadbolt enters the frame of the door (referred to as door edge protector).

   Reasoning: When a door unit is properly installed in a framed opening, according to best practice and the existing ordinance, it is next to impossible to insert a crowbar between the jamb and door and create enough space to disengage the deadbolt. We receive numerous complaints from homeowners about the ugly appearance of these items on their doors, especially regarding front entry doors. Homeowners are most likely removing these items from their doors after they occupy the home.

Since the introduction of these requirements much has changed in the home security field. Today we have keyless entry systems, wireless cameras on the exterior of homes, wireless camera door bells, wireless alarm systems for the entire or portions of the home. These systems are being used by more homeowners due to reduced or little cost for installation and use of the systems.

The KC HBA feels that these three modifications will have little or no impact on home security.

BUILDING PLANNING CHAPTER 3

R302.13, Protection of Floors
It is requested that an additional exception #5 be added to this section as follows:

R302.13, Exceptions, 5. Wood I-joists.

Reasoning: Wood I-joists were developed over 50 years ago. They have been used in home construction since the early 1970s. (I first used I-joists in 1982 in Roeland Park for a new home construction). I-joists have continued to grow in use across the US—in 2010, 470M lineal feet were produced in the US and Canada, in 2017, 790M lineal feet. At the same time the number of fire fighter deaths has continued to decrease each year. In 2017, it was reported that 60 fire fighters lost their lives in incidents related to all firefighting activities. Of these 10 were due to being struck and killed by vehicles. At least ½ or 30 fatalities were due to "sudden cardiac death" on the fire scene. The reporting systems used in the US are inadequate in scope to assist us in defining the reason for a fatality. The table below shows the trend by year of on scene fire deaths.

YEAR	# FIRE CALLS	#FATALITIES
2010	1.3 BILLION	22
13	1.2	57
14	1.3	22
15	1.3	24
16	1.3	15

During the review of the 2012 IRC by JOBO and cities in the metro area, the review by the two largest municipalities (Overland Park & KCMO) resulted in the proposed exception being adopted in their codes. Part of the information submitted at that time was a report by APA titled "Fire Protection of Floor Systems" which is provided within TAB 3 of this booklet. It shows I-joists performing well in actual burn tests. Another report that was reviewed by the American Forest & Paper Association titled "How Fire Safe are Homes with Wood I-joists", again shows outstanding performance of wood I-joists. This report is located within TAB 4 of this booklet.

It is interesting to note that the IBC (2012, 15, or 18) does not have a requirement for protection of wood I-joists in that code, therefore a home, if the plans were sealed by an engineer, could be built under the IBC without the requirement of ½" gypsum board on the underside of the joist.

According to both NFPA and FEMA, the leading areas of fire origin in single family homes are: cooking area/kitchen, bedrooms (probably smoking in bed), common areas-- living room or family room, attic, exterior wall surfaces, laundry area, and the vehicle storage area. Unfinished basements are not mentioned in the reports.

NFPA also reported that 46% of SF fires were limited to the object of origin of the fire, and 21% limited to the room of origin, with 5+% limited to the floor of origin. Total % is 73%.

As these studies and information show, basement fires are few and far between; wood I-joists are safe products to use in new home construction and should be approved without the requirement for gypsum or other protection.

There are other great advantages to using wood I-joists among them being that the floor is level and true, they assist in reducing floor squeaks and do not deflect as much as lumber joists. They are a safer product during construction—lighter, easier to handle reducing the chance of worker injury during framing. They are a safe desirable product from the consumers view.

Many single-family homes that have unfinished basements are the most affordable homes that our industry can produce. Affordability is a significant issue in the sale of new homes; most buyers would rather purchase a new home vs used or older home. We all know that new homes are much safer due to better electrical systems, safer plumbing systems, newer appliances with safeguards built-in, better fire blocking and sealing, etc. Most if not all of these homes are purchased by homeowners, with the intent to sometime in the future finish all or large portion of the unfinished basement. The cost to the builder to frame down around HVAC ducts and plumbing lines and install ½" gypsum board will range from $800 to $1200 or more; all or most of the cost lost at such time that the owner chooses to "finish" their basement. This is not good economics.

R313 Fire Sprinklers—Per both Kansas and Missouri state law remove this requirement from the IRC.

ELECTRICIAL PART VIII
CHAPTERS 34, 35, 36, 37, 38, 39, 40, 41

Before we start our discussion of items that need to be addressed in these sections of the code each person or entity reviewing this needs some background information.

These chapters in the IRC are lifted in their entirety directly from the NFPA National Electrical Code. No ICC committee is allowed to review, suggest modifications, or even propose changes to the NEC. We, KCHBA, do NOT know why this exists and have asked that ICC develop its own electrical code.

In the late 1990s & early 2000s when the ICC was forming and trying to get "its" codes adopted by the various states and local jurisdictions NFPA created its own "building code" in direct opposition to ICC and tried hard to convince jurisdictions to adopt the NFPA 5000 Building Code. The NAHB took a strong stand opposing NFPA and supporting ICC efforts to get the ICC codes adopted in as many jurisdictions as possible. As a result, we believe that NAHB was removed from all NFPA committees that develop code language in this and other areas. In some cases, when NAHB tried to submit testimony or recommend code language, they were ignored.

As a result we, NAHB and KC HBA, have no voice or input to the NEC. The only method of change is to come to the jurisdictions and ask that they amend or change specific sections of the electrical parts of the IRC. One of the tenants of the IRC found in Chapter 1-Scope and Administration-is affordability. We do not believe that NFPA considers that tenant.

We, the KC HBA, are asking that the following sections of the electrical chapters be modified:
Please note: We asked two builders to secure the additional cost for the items below, Bickimer Homes and Tom French Const. With standard markup the cost shown is what the impact to the consumer or home buyer would be. This applies to all of the following except E3901.7 and E3902.13.

E3901.7— Delete requirement for a receptacle on a balcony. There is NO definition of balcony in either Ch 35 or Ch 2 of the IRC. Many times the balcony in residential construction is purely ornamental in nature and no outlet is needed.

E3901.9— Delete requirement for a receptacle in each vehicle bay of garages. Of course this outlet would have to be GFCI protected. Today with most people using battery operated tools this requirement just cost money and is not needed. *Bickimer-$180, French-$204.

E3901.12— Delete requirement a receptacle within 25' of the outside HVAC compressor. Again, this is just another cost that is not justified. The KCHBA checked with 3 large HVAC dealers/service companies in the area—all told us that their service people only carry battery operated tools and do NOT use this called for outlet. (One did primarily new installations and the other two did repair and replacement work only.) *Bickimer-$90, French-$102.

E3902.10— Delete the requirement for a dishwasher on GFCI breaker. Delete the requirement for a dishwasher on GFCI breaker. This new requirement has NOT been justified to us. Yes, it would be nice to protect all circuits with GFCI, but not if we are to consider cost. There has been no justification for this requirement for an outlet that typically is in an out of the way location. Bickimer-$90, French-$72

E3902.13—GFCI required for heated floors—Again a new requirement with NO justification and only adding to cost of construction. KCHBA agrees if the heating cables are in the shower, but not just in other parts of the bathroom.

E3902.16— Delete Arc Fault breakers for all service. Again, another added cost that will cause many complaints from homeowners when ceiling fans, any appliance with motor windings, and many other stray factors cause interruption in their electrical service.
Attached is a memo provided by the Saint Louis HBA that was prepared this year as the local jurisdictions in their area considered the 2015 IRC—to our knowledge NO jurisdiction in the STL area is requiring arc fault protection. There has not been any scientific study showing that these devices provide anything other than very minimum safety benefit in new construction. The US Fire Administration reports have shown that electrical distribution fires are more common in older homes, more than 40 years old. In our geographic area most cities have only required arc-fault for the receptacles in bedrooms. While we would like to eliminate all arc-fault we will accept them for bedroom receptacles.* Bickimer-$1800, French-$612.

E4002.14— Delete the requirement for tamper resistant outlets. While we understand the idea of protection of young children who might stick something into an outlet, this requirement creates problems for older adults who may have bad joints and/or limited dexterity and have real difficulty in plugging in various appliances or devices. Unless the plug is directly centered on the outlet and inserted straight and true it will NOT engage. Again there has been no scientific data to support the claims that these devices are needed. *Bickimer-$110, French-$102.

Fire Protection of Floor Systems

Statistical Overview

Advantages of Engineered Components

- Many homeowners expect larger, more open homes than ever before.
- Engineered components (I-Joists and Trusses) allow for longer spans with fewer bearing points as compared to dimensional lumber.
- Engineered components allow for concealment of mechanicals within the floor container, reducing the need for bulkheads.
- Engineered components provide exceptional quality and known, consistent performance in structures.
- Construction is often much faster using engineered components as compared to “stick framed” structures.

What the Code States

- 2012 IRC
  - R501.3 – Fire protection of floors.
    - Floor assemblies shall be provided with a ½” gypsum wallboard membrane
    - Alternatively, 5/8” wood structural panels may be applied.
      - Exceptions:
        - Floors directly over areas with fire sprinklers
        - Floors located over a crawl space with no storage or fuel fired appliances
        - Small floor areas (Less than 80 sq. ft.)
        - Floor assemblies constructed with dimensional lumber or structural composite lumber of 2x10 or larger materials.
    - This means that most floors constructed of I-Joists or Trusses would now require sheathing on the bottom face.

What Do Actual Burn Tests Show?

- Tests show loaded floor systems (with no bottom sheathing) failure times

ASTM E119 Assembly Tests at Full Design Load[2]

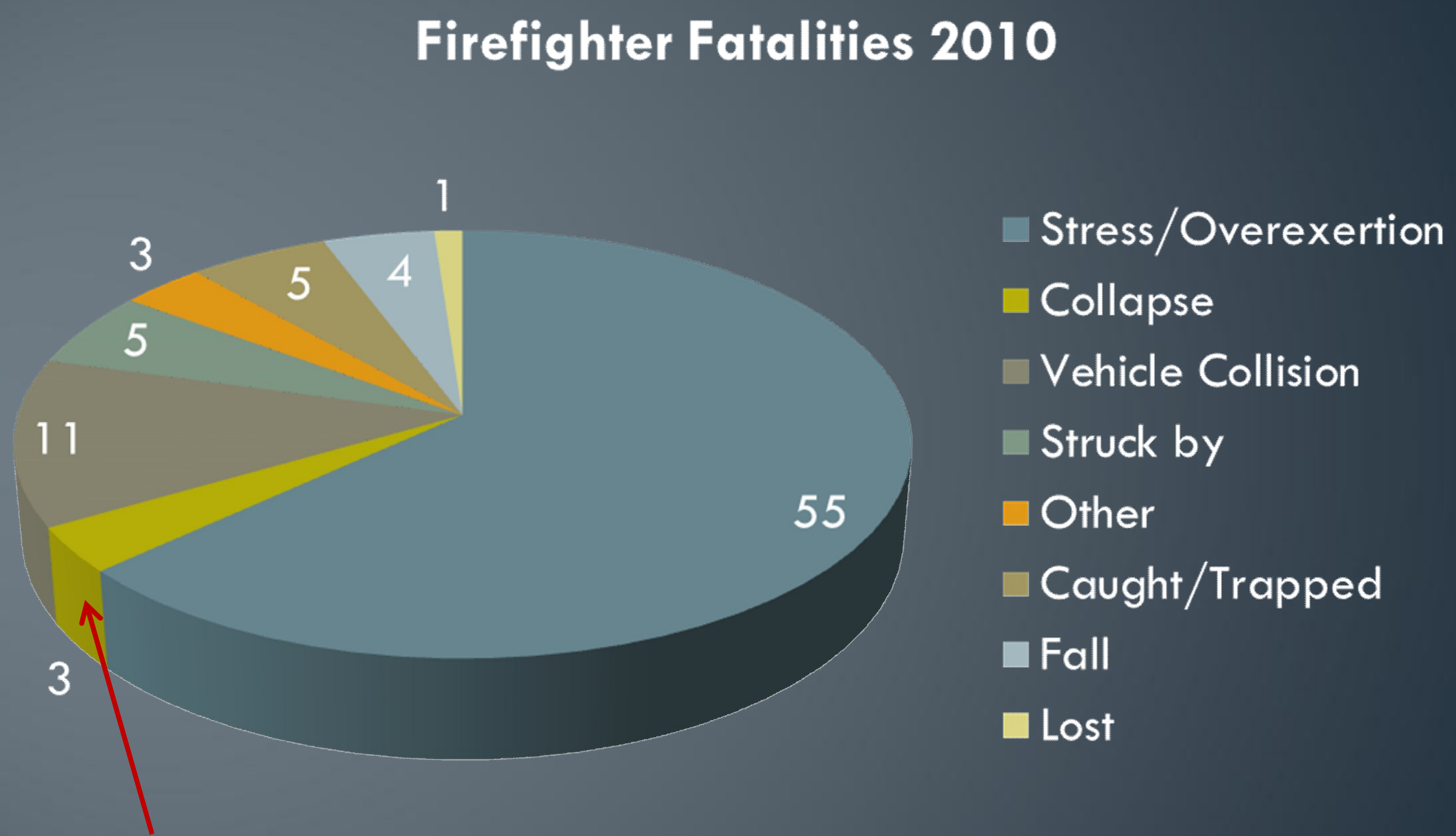
Test	Structural Member	Spacing (inches o.c.)	Structural Failure (min:sec)	Average Deflection at Floor (inches)	Loading (psf) - Percent Design Stress
FM FC 209	2x10	24	13:34	2.83	62.1 - 100%
FM FC 212	2x10	24	12:06	3.58	62.4 - 100%
NBS 421346 (2)	2x10	16	11:38	2.7	63.7 - 100%
NBS 421346 (4)	2x10	16	11:38	3.3	63.7 - 100%
FPL	2x10	16	6:30	4.0	79.2* - 100%
FM FC	12" Truss**	24	10:12	11.5	60.0 - 100%
FM FC 208	7¼ Steel C-joist	24	7:30	7.0	69.8 - 100%

*This load may be greater than 100% of design load. **Refers to a Metal Plate Connected Wood Truss.

Table 1: *ASTM E119* Assembly Tests at Full Design Load

- 2x10 performance varies from 6 min 30 sec to 13 min 34 sec.
- 12" deep truss failure at 10 min 12 sec – Well within 2x10 failure range
- Other studies have shown that structural failures of floor systems collapse times can likely be doubled for any floor system with sheathing attached to the bottom face.

Statistics - 2010



- Total 3 of 87 deaths from a collapse (3.4%)
  - 1 death from roof collapse
  - 2 deaths as a result of a bearing wall failure

Statistics Continued

- 2009 – 2 fatal injuries from collapse out of 77 total fatalities
  - Both firefighters died when a floor of a *commercial* building collapsed.
    - 2x dimensional lumber with no bottom sheathing.
- 2008 – 5 fatal injuries from collapse out of 107 total fatalities
  - Two firefighters died from smoke inhalation after the *residential* floor collapsed
    - 2x10 dimensional lumber – No mention of bottom sheathing.
  - One firefighter died from a brick façade collapse on a *commercial* structure
  - 2 incidents of a *residential* roof collapse with the firefighter in the attic.
- 2007 – 7 fatal injuries from collapse out of 118 total fatalities
  - 2 of these fatalities resulted from *residential* floor collapses
    - 1 floor was constructed of dimensional lumber – No mention of bottom sheathing
    - 1 floor was constructed of engineered products – No bottom sheathing

Statistics Recap

- 389 Firefighter deaths in 2007-2010
  - 212 deaths due to Stress or Overexertion (Heart Attacks)
  - 17 deaths due to collapse
    - 6 deaths due to floor collapse
      - Of these 6, 4 were residential floors
        - Of the 4 residential floors, only one would require sheathing per section R501.3
- There has been no conclusive evidence that shows that engineered wood product assemblies are likely to collapse in a substantially shorter period of time as compared to 2x10 or larger wood framing assemblies.

References

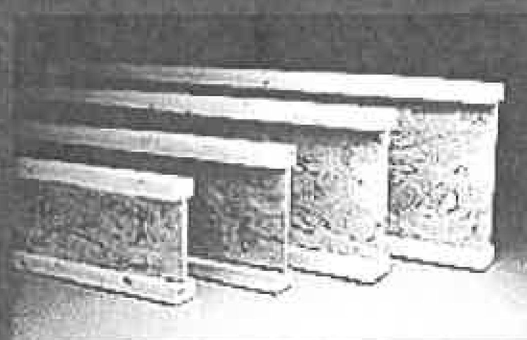
- 2012 International Residential Code – May, 2001
- APA Technical Topics TT-015D – July 2010
- http://www.sbcindustry.com/images/fireinsights/FI_Equivalency_Testing.pdf?PHPSESSID=rl9ndep8dm208oins286dnk3e6
- http://www.usfa.fema.gov/downloads/pdf/publications/ff_fat10.pdf
- http://www.usfa.fema.gov/downloads/pdf/publications/ff_fat09.pdf
- http://www.cdc.gov/niosh/fire/reports/face200923.html
- http://www.usfa.fema.gov/downloads/pdf/publications/ff_fat08.pdf
- http://www.cdc.gov/niosh/fire/reports/face200809.html
- http://www.usfa.fema.gov/downloads/pdf/publications/ff_fat07.pdf
- http://www.cdc.gov/niosh/fire/reports/face200707.html
- http://www.sbcindustry.com/images/fire/firecomdata.pdf
- http://www.woodbywy.com/literature/1500.pdf

How Fire Safe are Homes with Wood I-Joists?

Primary Considerations

- Safety of occupants
- Safety of firefighters

Let's take a look at **both**

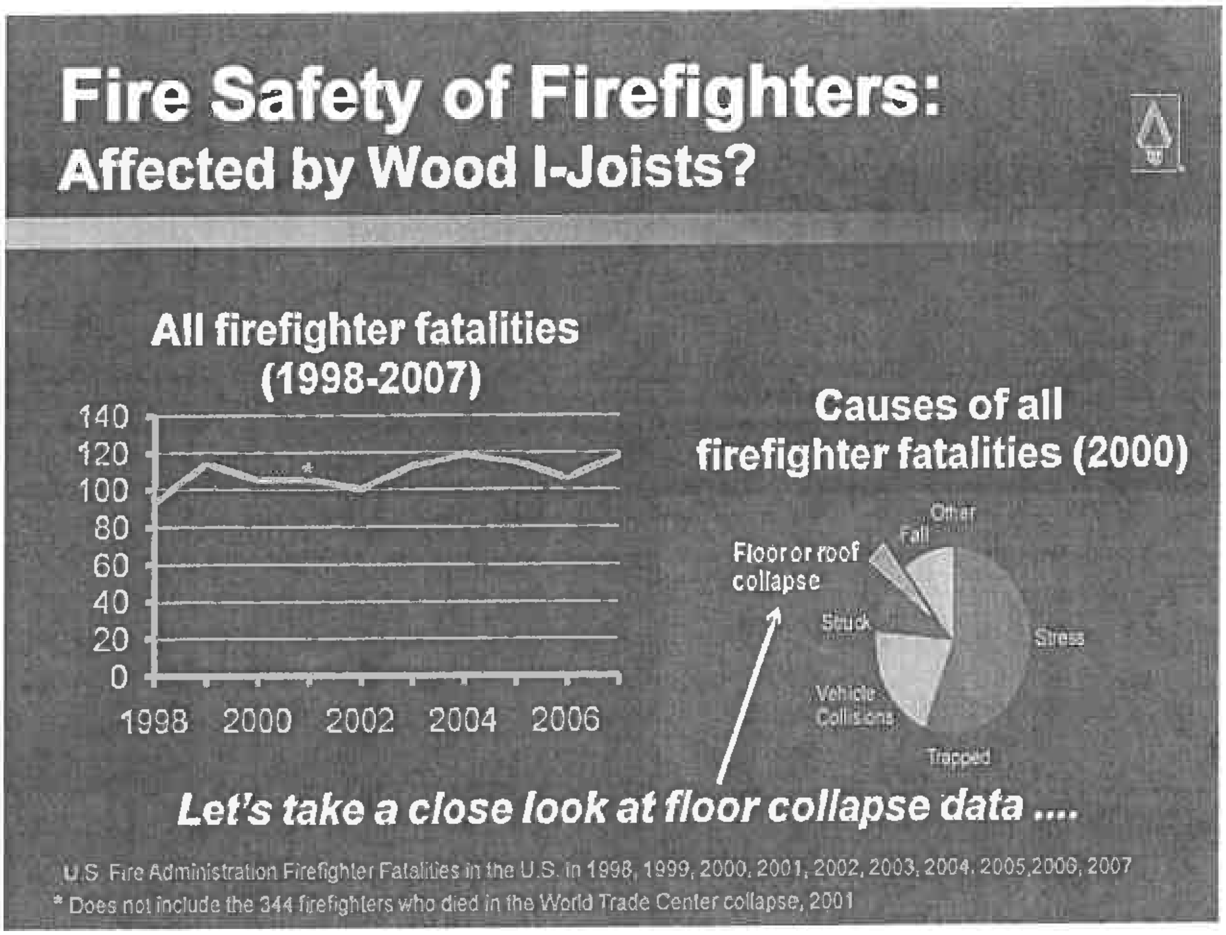


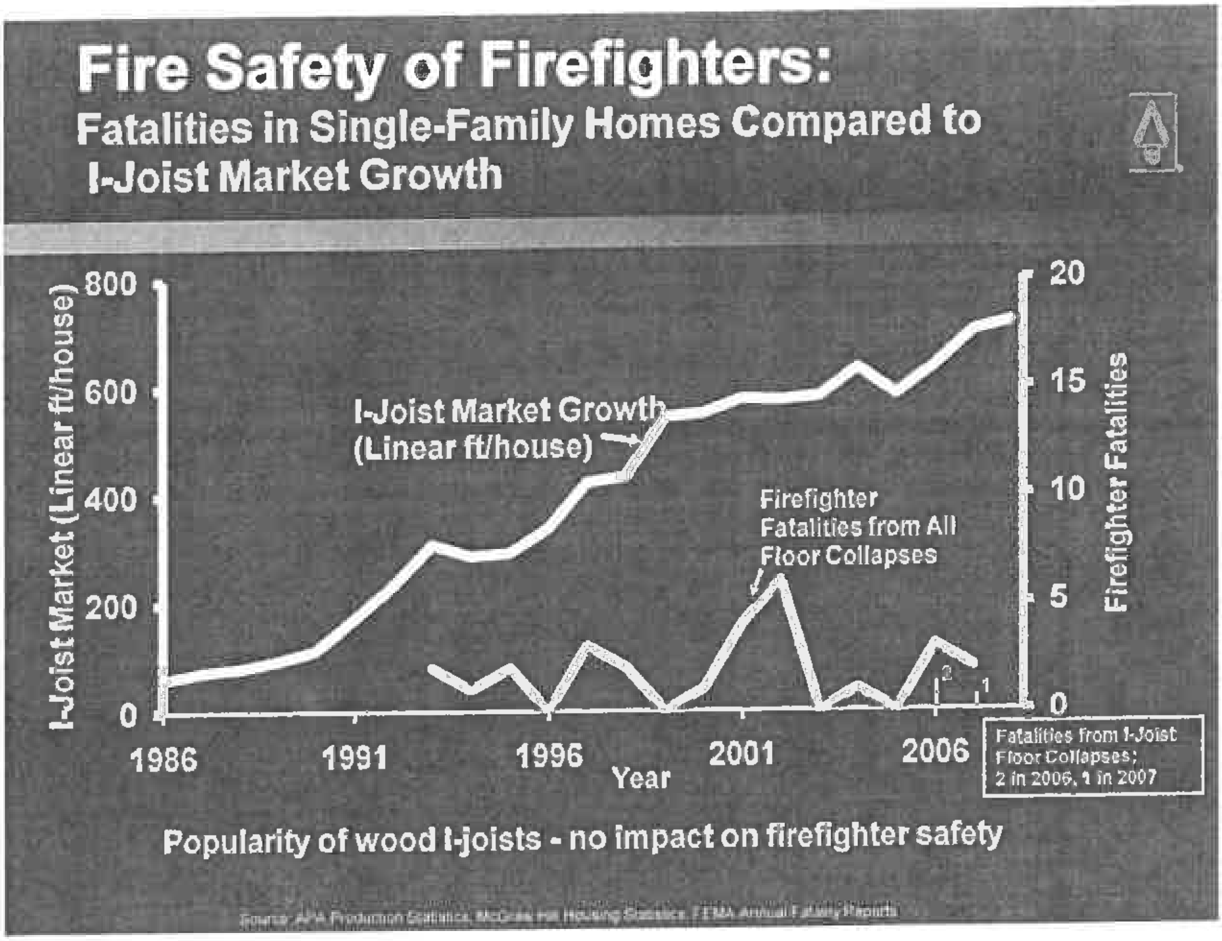
Fire Safety of Occupants:

Trends and Causes of Fatalities

20% reduction in occupant deaths in a decade

Fire in the United States 1995 to 2004, USFA Report FA-311, 2007, Figure 18
Residential Structure and Building Fires, USFA Report, October [illegible], Figure 3


Fire Safety of Firefighters:
Affected by Wood I-Joists?
All firefighter fatalities
(1998-2007)
140
120
100
80
60
40
20
0
1998
2000
2002
2004
2006
*
Causes of all
firefighter fatalities (2000)
Other
Fall
Floor or roof
collapse
Struck
Stress
Vehicle
Collisions
Trapped
Let's take a close look at floor collapse data ....
U.S. Fire Administration Firefighter Fatalities in the U.S. in 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007
* Does not include the 344 firefighters who died in the World Trade Center collapse, 2001



Fire Safety of Firefighters:
Fatalities in Single-Family Homes Compared to I-Joist Market Growth
I-Joist Market (Linear ft/house)
800
600
400
200
0
20
15
10
5
0
Firefighter Fatalities
I-Joist Market Growth (Linear ft/house)
Firefighter Fatalities from All Floor Collapses
2
1
1986
1991
1996
2001
2006
Year
Fatalities from I-Joist Floor Collapses; 2 in 2006, 1 in 2007
Popularity of wood I-joists - no impact on firefighter safety
Source: APA Production Statistics, McGraw Hill Housing Statistics, FEMA Annual Fatality Reports

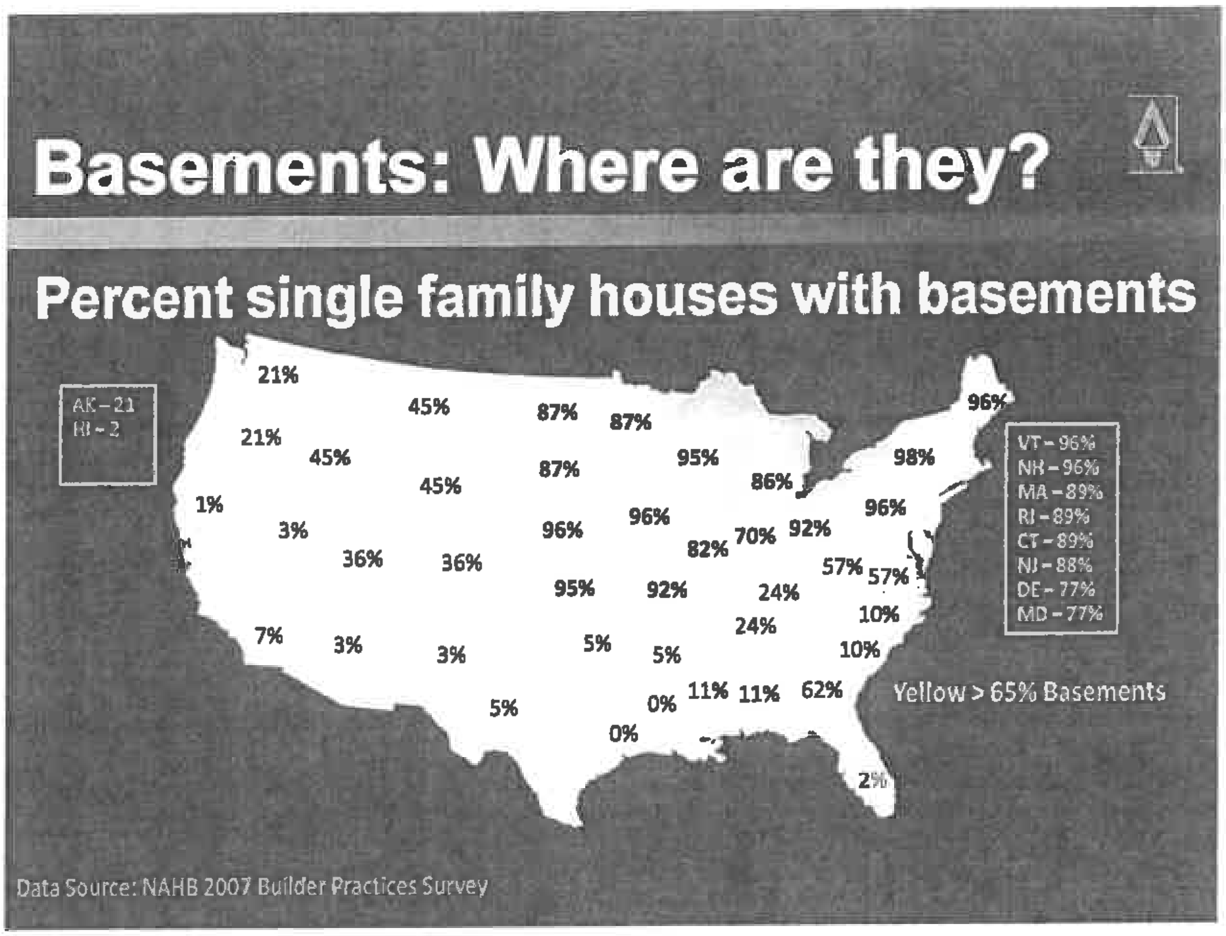
Firefighter Fatalities

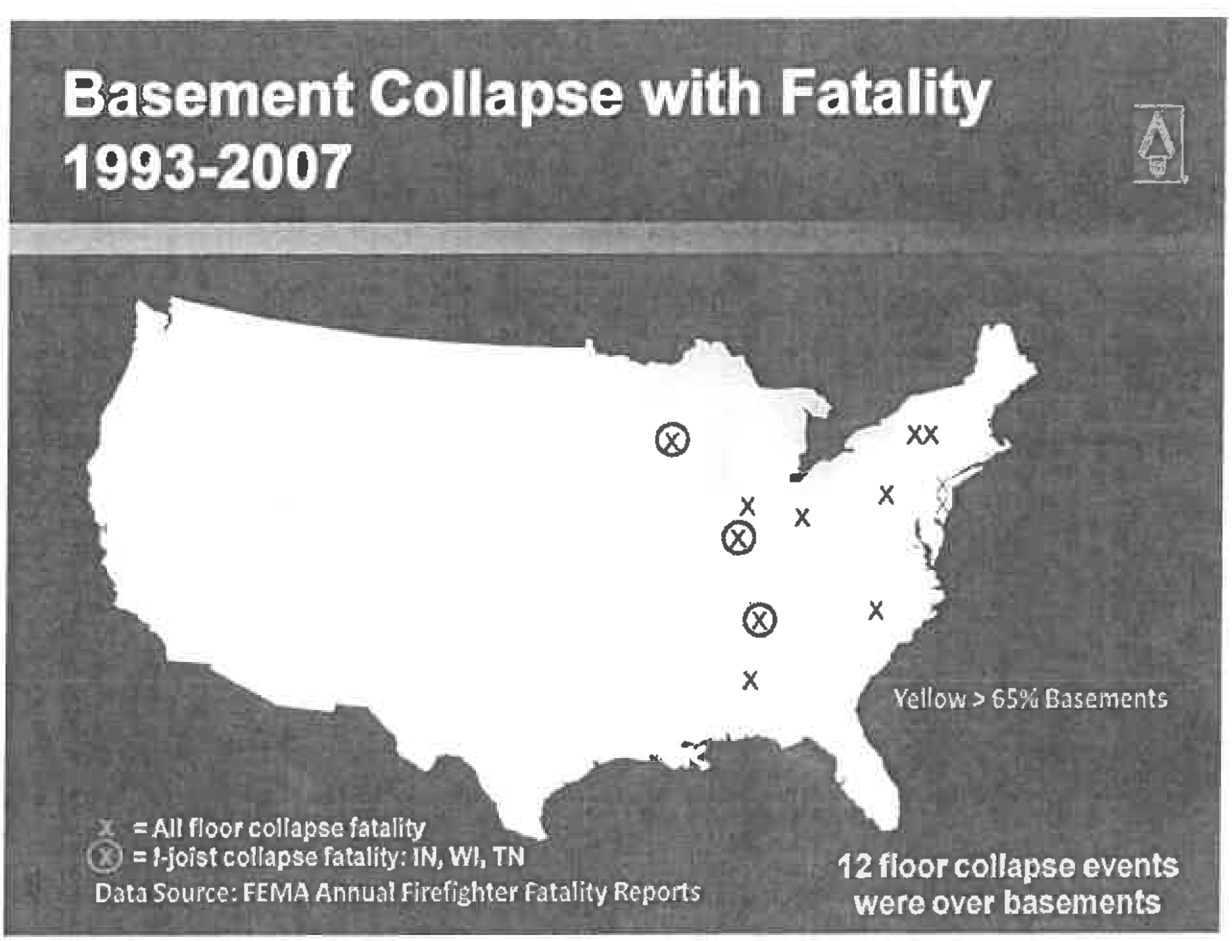
For the decade of 1998-2007

A total of 1033* firefighters died in the line of duty (all causes included)

- Of those 1033 ⟶ 61 died due to structural collapse
- Of those 61 ⟶ 19 died in single family floor collapses
- Of those 19 ⟶ 12 were over basements
- Of those 12 ⟶ 3 died in unprotected I-joist floor collapses over basements

* Does not include the 344 firefighters who died in the World Trade Center collapse


Basements: Where are they?
Percent single family houses with basements
AK – 21
HI – 2
21%
21%
45%
45%
45%
87%
87%
87%
95%
86%
98%
96%
1%
3%
36%
36%
96%
96%
82%
70%
92%
57%
57%
95%
92%
24%
24%
10%
10%
7%
3%
3%
5%
5%
5%
0%
0%
11%
11%
62%
2%
VT – 96%
NH – 96%
MA – 89%
RI – 89%
CT – 89%
NJ – 88%
DE – 77%
MD – 77%
Yellow > 65% Basements
Data Source: NAHB 2007 Builder Practices Survey


Basement Collapse with Fatality
1993-2007
XX
X
X
X
X
X
Yellow > 65% Basements
X = All floor collapse fatality
(X) = I-joist collapse fatality: IN, WI, TN
Data Source: FEMA Annual Firefighter Fatality Reports
12 floor collapse events
were over basements

Firefighter Education and Training

The wood industry is committed to providing education to the fire service to reduce firefighter deaths from collapse.

Firefighter Education and Training

- Product awareness guides
  - *www.woodaware.info*
- AF&PA website on fire performance of wood
  - *www.awc.org*
- Wood products display cases for firefighter training centers

Wood I-joist for hands-on training

Wood I-Joists: One of Many New Features of Modern Construction

Feature

- Larger homes
- Open floor plans
- Increased fire loads
- Floor/ceiling/attic voids
- New building materials

Fire Effect

- Faster fire propagation
- Shorter time to flashover
- Shorter escape times
- Shorter time to structural collapse

Source: UL University – Structural Stability of Engineered Lumber in Fire Conditions – Underwriters Laboratories

Summary

- Wood I-joists are popular, resource efficient, and recognized as green
- Use of wood I-joists has increased without a corresponding increase in firefighter deaths due to collapse
- Floor collapse fatalities occur primarily over basements
- Changes in building practices and modern furnishings create new challenges for the fire service

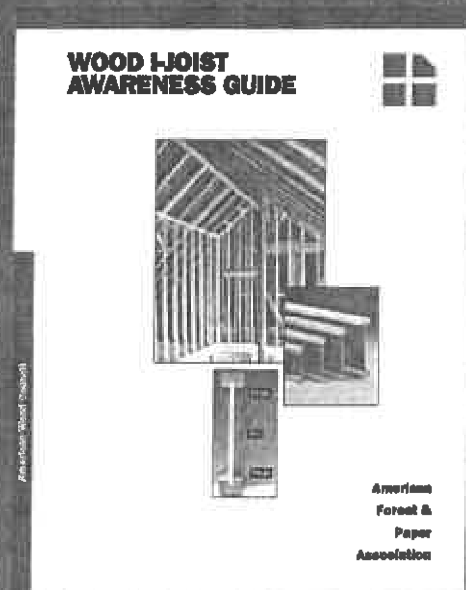
Our Commitment

AF&PA continues to work with fire service leaders to:

- define collapse risk of unprotected floors
- define factors that contribute to collapse
- develop solutions that meet their needs

Thank You

For more information,
please visit:
www.woodaware.info



Proposed Significant Changes from the 2012 International Residential Code to the 2018

Table R301.2(1) Climatic and Geographic Design Criteria.

Ice Barrier Underlayment Required. Yes

Change:

This section now requires two layers of roofing underlayment or a self-adhering polymer-modified bitumen sheet to be installed at the lowest edges of roof surfaces to extend to not less than 24 inches inside the exterior wall line. The added layers of protection prevent water damage to dwellings that are created from ice forming at the lowest point and thawing.

Section 507 Decks.

Change:

The IRC in previous adopted additions has not given prescriptive requirements for deck construction. The 2018 code now has a section for minimum deck design and construction.

Section E3901.9 Basements, garages and accessory buildings.

Change:

Requires receptacles to be installed in each bay of a garage.

E3902.16 Arc-fault circuit-interrupter protection.

Change:

This will require Arc-fault circuit-interrupter protection for all 120 volt 15 and 20 amp outlets in a house. This has previously been amended to only require arc-fault protection in bedrooms.

Section E4002.14 Tamper-resistant receptacles.

Change:

This will require all accessible 15 – 20 amp receptacles to be tamper resistant.

Packet Information

File #: TMP-0996, **Version:** 1

Adoption of the 2018 Property Maintenance Code

Issue/Request:
The Property Maintenance Code is a set of sample codes created by the International Code Council to address the ongoing maintenance and safety of all properties within a jurisdiction. The Development Services Department currently enforces chapter 16 of the city's code of ordinances that covers the outside of properties with regards to upkeep and safety conditions. These current codes were adopted based off of the Property Maintenance Code from the 2000 edition and modified for city use.

Under current code unsanitary and unsafe conditions that exist within a property have few avenues for the city to move corrections forward. The adoption of the Property Maintenance Code would assist in filling in this gap in coverage of our existing code as well as aligning it more closely to how our current building and fire codes function through a six year adoption cycle based on new codes with adopted modifications to meet our local needs and expectations.

Earlier this summer Development Services formed a Citizen feedback and review team that had citizens go through the code with city staff to provide input on what they thought should be adopted or not, as well as any potential modifications. This group consisted of business owners, residents that were both owners and renters, and landlords from all reaches of the city.

In general the code was well received with the two primary concerns being the question of if government should be enforcing standards on the interior of a property and concerns about overzealous enforcement. Under current operations the city has few mechanisms for corrective actions on the interior of a property which could allow unsafe conditions to remain in place that could lead to for example a higher chance for a fire. The Neighborhood Services group that currently enforces property maintenance is a complaint driven group that reacts to submissions to the city and does not currently proactively seek violators. In addition access to the interior of a property for these officers must be granted prior to entering to review code compliance.

Throughout this review process citizens made several comments as to how they see this code affecting the community. The feedback is found in the corresponding document which also contains staff's recommendations and an indication as to what currently exists in ordinance, what is new, or what has been modified.

Proposed Committee Motion:
I move to recommend to the City Council approval of AN ORDINANCE REPEALING CHAPTER 16, LEE'S SUMMIT PROPERTY MAINTENANCE CODE OF THE CODE OF ORDINANCES OF THE CITY OF LEE'S SUMMIT, MISSOURI, AND ENACTING A NEW CHAPTER 16 PERTAINING TO THE SAME SUBJECT MATTER, FOR THE CITY OF LEE'S SUMMIT, MISSOURI.

Dan Harper and Tracy Deister

To: Community and Economic Development Council
From: Development Services Department
Date: November 5, 2018
Re: International Property Maintenance Code Adoption

The Property Maintenance Code is a set of sample codes created by the International Code Council to address the ongoing maintenance and safety of all properties within a jurisdiction. The Development Services Department currently enforces chapter 16 of the city's code of ordinances that covers the outside of properties with regards to upkeep and safety conditions. These current codes were adopted based off of the Property Maintenance Code from the 2000 edition and modified for city use.

Under current code unsanitary and unsafe conditions that exist within a property have few avenues for the city to move corrections forward. The adoption of the Property Maintenance Code would assist in filling in this gap in coverage of our existing code as well as aligning it more closely to how our current building and fire codes function through a six year adoption cycle based on new codes with adopted modifications to meet our local needs and expectations.

Earlier this summer Development Services formed an outreach panel to gather feedback through a review team of Lee's Summit citizens go through the code with city staff to provide input on what they thought should be adopted or not, as well as any potential modifications. This group consisted of business owners, residents that were both owners and renters, and landlords from all reaches of the city.

In general the code was well received with the two primary concerns being the question of if government should be enforcing standards on the interior of a property and concerns about overzealous enforcement. Under current operations the city has few mechanisms for corrective actions on the interior of a property which could allow unsafe conditions to remain in place that could lead to for example a higher chance for a fire. The Neighborhood Services group that currently enforces property maintenance is a complaint driven group that reacts to submissions to the city and does not currently proactively seek violators. Any code enforcement on the interior of a property would require the resident to willingly grant access to the officer prior to reviewing a situation for compliance to these codes.

Throughout this review process citizens made several comments as to how they see this code affecting the community. The feedback is found in the corresponding document which also contains staff's recommendations and an indication as to what currently exists in ordinance, what is new, or what has been modified.

The attached feedback identifies which sections of the Property Maintenance Code currently exist within current city code, what has been modified, and what is new that does not currently exist. For each section of code the citizen's comments and concerns were listed based on the review panel, staff's recommendations are then listed, and finally the input provided by the Board of Appeals meeting from August 2018. Any section that contains a recommended change from city staff based on input as well as experience using the current code is in bold print as well as found in the ordinance language.

The list below is an abbreviated version of the most significant changes recommended and the most contentious items that were discussed with both the citizen panel and the Board of Appeals.

Section 302.3 – The City's current practice is to not require property owners and residents to shovel/clear their sidewalk of snow and ice. The proposed property maintenance code includes provisions for this removal. To stay consistent with past practices staff recommends striking a portion of this section to remove this requirement.

Section 302.4 – Currently the city's maximum allowable grass length is 10 inches. The code allows each jurisdiction to input their desired maximum length. Staff recommends maintaining past practices and continuing forward with the 10 inch requirement.

Section 304.14 – The city does not currently require screens to be placed on all windows and doors in the city. This section of the code requires the placement of screens on all windows and doors that can be opened and allows the jurisdiction to establish dates for when they are required. Based on citizen feedback and Board of Appeals recommendations, staff recommends striking this section of the code removing the requirement of screens.

Section 305.3 – This code establishes requirements for maintaining interior surfaces of buildings. The general feel of the citizen's group was that they didn't think it was a hazard and that it should not be a decision by the city as to when they need to maintain the paint of their house. There were also several concerns about when paint has become deficient and needs repair. Based on this feedback the Board of Appeals also agreed with their concerns and staff recommended striking this section of code.

Section 308.2 - This section requires the owner to of a property to remove garbage and rubbish. Staff recommends modifying this code so that person(s) generating garbage and rubbish are held responsible for their disposal in the instance that the occupant is different than the owner.

The following document contains the review of the code pertaining to the citizen review group as well as staff recommendations. The 2018 International Property Maintenance Code can be found at: https://codes.iccsafe.org/public/document/IPMC2018.

Status Legend:
Cur. = Currently adopted or very similar to currently adopted code.
New = New code that is not currently adopted in the municpal code anywhere.
Mod. = Modified code from existing. A portion may have changed from existing.
Staff Recommendations in bold represent proposed changes to the base code.

Chapter 3 - General Requirements				
Section	**Status**	**Citizen Input**	**Staff Recommendation**	**Board of Appeals Comments**
301: General				
301.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
301.2	New	Several citizens expressed confusion if this code clearly specifies who is the occupant-owner and if renters are responsible. There were additional concerns that this wouldn't cover commercial buildings based on the current phrasing. The two proposals made were to remove the dwelling units from the language and to consider adding wording to cover commercial properties. Some citizens also found the 2018 code acceptable as is.	Staff interprets the code as a whole applies to all properties and does not make exceptions for residential or commercial unless stated. Staff recommends no change to the wording as dwelling units should be included. Staff recommends to adopt as written.	No comments.
301.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
302: Exterior Property Areas				
302.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.

302.2	New	Citizen's proposed changes to include detention as an exception since retention is not the same. The other concern was that the code doesn't clearly establish what is a pond and what is standing water.	Staff does not recommend including detention as they should drain to no standing water if properly designed & maintained in accordance to the Design and Construction Manual. Staff does not recommend defining a pond at this location as the section is defined as grading and drainage therefore standing water should not be created as a result of grading and drainage. A pond/reservoir would be a designed feature and not a nuisance of standing water. Staff recommends to adopt as written.	No comments.
302.3	Cur.	Citizen's provided mixed feedback as to if removal of snow & ice should be an exception or should be required. Some citizens supported this idea while others rejected it.	**The city has historically never defined a requirement for the removal of snow & ice conditions from public or private sidewalks/drives or similar areas. Therefore to remain consistent with past practices, the staff recommends adopting the code as "Sidewalks, walkways, stairs, driveways, parking spaces and similar areas shall be kept in a proper state of repair." - striking the rest of the sentence.**	The Board shared some comments about the requirements within the city noting that different subdivisions can have their own rules. Staff made mention that the consistency across the KC Metro area varies based on the city and that there is not a consistent convention and that the modification to the code follows existing practices.
302.4	New	No comments	**Staff recommends to adopt as written with the maximum weed height to remain the 10 inches as is currently adopted.**	The Board commented that historically it was 12 inches and was decreased to 10 inches around 6 to 8 years ago. The Board also internally discussed if this applied to cultivated plants and the conclusion was that it did not.

302.5	Cur.	No comments	Staff recommends to adopt as written.	No comments.
302.6	Cur.	No comments	Staff recommends to adopt as written.	No comments.
302.7	Cur.	No comments	Staff recommends to adopt as written.	No comments.
302.8	New	One citizen proposed that vehicles should be allowed to be stored in the backyard if it was fenced regardless of opperability.	Staff recommends to adopt as written staying consistent with past practices.	The Board asked if this was currently regulated, staff responded that we do have a current ordinance that regulates this. It is not allowed at this time.
302.9	Cur.	No comments	Staff recommends to adopt as written.	No comments.
303: Swimming Pools, Spas and Hot Tubs				
303.1	Cur.	No comments	**Staff recommends to adopt the following, "Swimming pools shall be maintained in a clean and sanitary condition, and all components of the pool maintained in a functioning state. Abandoned or unused swimming pools, spas, and hot tubs that do not meet these conditions may require removal at the discretion of the codes official."**	The Board asked why the change was requested and staff explained that it was rooted in a case where it a pool was covered and no longer in use but was not being maintained. Staff had few options to address the situation where the pool had fallen into disrepair but was covered.
303.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
304: Exterior Structure				
304.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.

304.1.1	New	Citizens raised concern that the city shouldn't be checking caulking on houses as it isn't their role. Others stated that non-visible items aren't a life safety issue and should not be included. Some citizens did support this as it could be utilized by a renter to encourage a landlord to make repairs.	The comment on caulking was in reference to item #4. Staff interprets this code as a reference towards a larger hole that would be as a result of missing trim, flashing, or an actual hole. Staff also could identify items that would be non-visible that could require enforcement and could be a life safety issue. An example would be a leaning building that may have structural damage but it would be non-visible. Therefore staff recommends to adopt as written.	Staff made additional comments that the city currently addresses a lot of these issues that are listed. Staff commented that we might add the international residential code with the international building code to this one. The Board indicated that adding those would be acceptable.
304.2	Mod.	No comments	Staff recommends to adopt as written.	No comments.
304.3	Cur.	Some citizens questioned that this shouldn't be a requirement if the structure was so far from the road that it could not be seen from the street and proposed an exception for this situation. Another suggestion was to place limits on the size of the numbers allowed.	Staff does not agree with an exception to not have an identifier on the property as it could be related to a fire/police issue where they could need an identifier that is visible. Staff does not agree that a maximum size limit is required at this time. Therefore staff recommends to adopt as written.	No comments.
304.4	Cur.	No comments	Staff recommends to adopt as written.	No comments.
304.5	Cur.	No comments	Staff recommends to adopt as written.	No comments.
304.6	Cur.	No comments	Staff recommends to adopt as written.	No comments.
304.7	Cur.	No comments	Staff recommends to adopt as written.	No comments.
304.8	Cur.	No comments	Staff recommends to adopt as written.	No comments.
304.9	Mod.	No comments	Staff recommends to adopt as written.	No comments.
304.10	New	No comments	Staff recommends to adopt as written.	No comments.
304.11	Cur.	No comments	Staff recommends to adopt as written.	No comments.
304.12	Cur.	No comments	Staff recommends to adopt as written.	No comments.
304.13	Cur.	No comments	Staff recommends to adopt as written.	No comments.
304.13.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.

304.13.2	Cur.	Some citizens were against the requirement to have a window as openable that it shouldn't be of the city's concern.	**Staff finds that there may be some safety implications with this section of code with regards to a falling window landing on a persons fingers/hand or breaking the window if it were to fall. Staff has concerns with the ability to enforce this section of code as it would require an officer to check each window upon inspection. Staff recommends adoption of the following: "Every window, other than a fixed window, shall be easily openable." - striking the rest of the sentence.**	The board asked how this ordinance was enforced, particularly in older homes that have painted multiple times where the seams are painted shut. The response from staff was that entry to the house would need to be made for other reasons and that it wouldn't be enforced through active patrol.

304.14	New	Some citizens had concerns about the use of habitability were raised as not being sufficient to evict a renter in court. Others also had concerns that this shouldn't even be a city ordinance to require.	Staff finds that if a window is required for ventilation but it cannot be opened without a screen, it is therefore unusable for the intended purpose. Therefore staff recommends adopting the code as written but with the dates striken. Due to the seasons of the year in this location staff does not find that limiting the season provides any benefit.	**The definition of a self closing device was asked by the Board: One that will close without human intervention. Such as a spring on a screen door. This applies to windows that are required for ventilation. If there is a window and a door in the room the door would not have to have a screen. Mechanical ventilation is acceptable in lieu of a door or window. The question was then asked if there are specific places that have to have a window? Ventilation can occur through natural means or mechanical. This code refers to openings for ventilation only. Screens are required on openable doors and windows that are used for ventilation. Chapter 401.3 alternative devices which refers to mechanical ventilation and artificial light. It is suggested that this paragraph be struck from the code. The Board of Appeals agrees to strike this paragraph.**
304.15	New	No comments	Staff recommends to adopt as written.	No comments.
304.16	Cur.	No comments	Staff recommends to adopt as written.	No comments.

304.17	New	Some had concerns that this section of code would require multiple layers of protection. Recommendations were to make a list of approved materials rather than leaving it up to the codes official. There were also concerns that it would be to strict on home owners. A recommendation was made to strike this whole code.	Staff finds that this code does not mean multiple layers of protection are required. Staff also does not agree with making a list as it would constrain the potential use of a new material that would be acceptable or the use of a material that was inadvertently omitted which would require judgement to be made by the codes official. Therefore staff recommends to adopt as written.	Is that as easy as a screen on the window was asked. Staff responded that a screen would meet the requirements of the code.
304.18	New	No comments	Staff recommends to adopt as written.	No comments.
304.18.1	New	Citizens had concerns that the termonology is not consistent with earlier chapters. There was some concern that the code would not allow for some newer lock technologies to be acceptable. A recommendation was made to strike the word deadbolt out and to allow any lock that is a minimum of at least 1 inch in size.	**Staff recommends to adopt as written and to add an exception "Locks not confroming to the code may be accepted by review of the codes official". This would allow for the flexibility to accept new lock technology that could meet the code requirements.**	The Board commented that new construction has a secruity code based on the principles adopted 10+ years ago. This would apply to older homes that did not have this security code when constructed.
304.18.2	New	No comments	Staff recommends to adopt as written.	No comments.
304.18.3	New	No comments	Staff recommends to adopt as written.	No comments.
304.19	New	No comments	Staff recommends to adopt as written.	No comments.
305: Interior Structure				
305.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
305.1.1	New	No comments	Staff recommends to adopt as written.	No comments.
305.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.

305.3	New	Citizens had mixed feedback on this code. Fears about children eating paint were raised to support it and others thought that the government shouldn't dictate this as it was their paint to look at. Home owners recommended an exception for owner-occupied while landlords heavily opposed this. Some thought that this wasn't required because existing health laws covered this and that nothing should be included.	**Staff recommends striking this code as the code is potentially to subjective for enforcement.**	Board of Appeals agrees with striking this section of code.
305.4	Cur.	No comments	Staff recommends to adopt as written.	No comments.
305.5	Cur.	No comments	Staff recommends to adopt as written.	No comments.
305.6	New	Citizens raised concerns about this being overreach to enforce.	Staff recommends to adopt as written.	No comments.
306: Component Serviceability				
306.1	New	No comments	Staff recommends to adopt as written.	No comments.
306.1.1	New	Some citizens disagreed with this even being an ordinance to maintain. Others had concerns that the materials list was not inclusive enough and needs expanded. Some thought existing code already covered this so duplication was not required.	Staff finds that the list of materials is sufficient and materials not listed could be reviewed on a case by case basis by the codes official. Staff recommends to adopt as written.	Staff made additional comments that ome of the language is currently in the code as written today, but may be more vague. A lot of this can be addressed by current code.
307: Handrails and Guardrails				
307.1	New	It was identified that this section of code applies to both commercial & residential under building codes which are different. The recommendation was made to add a section 307.2 and state that commercial properties should match the existing city building code.	**Staff recommends to adopt the following, "Every exterior and interior flight of stairs having more than four risers shall have a handrail and guardrails as required by the building code at the time of construction or shall meet the following…"**	Staff made note that this doesn't match the residential or building code. Thus the addition of the language.
308: Rubbish and Garbage				

308.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
308.2	Cur.	No comments	**Staff recommends to adopt as, "Every occupant of a structure shall dispose of all rubbish in a clean and sanitary mannner by placing such rubbish in approved containers and disposing of such rubbish in an approved disposal facility."**	The Board asked staff to differentiate between rubbish and garbage. Staff explained that garbage is generated from daily activities. Rubbish is used appliances, yard debris etc.
308.2.1	New	No comments.	**Staff recommends striking this code as it has traditionally been the City's practice to hold the individuals producing the rubbish as responsible for disposal.**	Board of Appeals agrees with striking this section of code.
308.2.2	New	Citizens made the recommendation to remove this line of code as rubbish includes refridgerators.	Staff recommends to adopt as written as refridgerators are rubbish, but rubbish that require an additional step to avoid a potential life/safety issue.	No comments.
308.3	Cur.	No comments	Staff recommends to adopt as,"Every occupant of a structure shall dispose of garbage in a clean and sanitary manner by placing such garbage in an approved garbage container and disposing of garbage in an approved disposal facility."	No comments.
308.3.1	New	No comments	Staff recommends to adopt as written.	No comments.
308.3.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
309: Pest Elimination				
309.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
309.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
309.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
309.4	Mod.	No comments	Staff recommends to adopt as written.	No comments.
309.5	Cur.	No comments	Staff recommends to adopt as written.	No comments.

N/A	N/A	It was recommended to add a section of code that covers if a neighbor caused an infestation but no suggestion on how to phrase it was given.	Staff does not recommend to add an additional section as specific situations as suggested by the citizens should go through a judicial body such as civil court and are not a maintenance related issue.	No comments.
Chapter 4 - Light, Ventilation and Occupancy Limitations				
401: General				
401.1	New	No comments	Staff recommends to adopt as written.	No comments.
401.2	New	No comments	Staff recommends to adopt as written.	No comments.
401.3	New	Citizens made a recommendation that this code should also include the residential and building code.	Staff recommends to adopt as, "In lieu of the means for natural light and ventilation herein prescribed, artificial light or mechanical ventilation complying with the International Building Code or International Residential Code shall be permitted." and agrees with this citizen's comments.	**Board of Appeals recommended changing the language to read "adopted codes" in lieu of IBC/IRC. Based on these comments staff recommends to adopt "In lieu of the means for natural light and ventilation herein prescribed, artificial light or mechanical ventilation complying with the adopted codes shall be permitted."**
402: Light				

402.1	New	Citizens recommendation is to hit the 8% as based on the code at the time of construction. There was a lot of concerns about this not being necessary and that it isn't a safety issue and served no purpose.	Staff recommends to adopt as written. The comments from the citizens group we are not in agreement with as compliance of this code can easily be made compliant with the methods described in 401.3 and would not require significant modifications to a structure as was the fear described.	Staff added clarity before the Board that this section and the next section (ventilation) indicate where it's possible to have natural light and ventilation. Where it's not possible use mechanical means. A variance could be requested where this code is not possible. The Board requests a modification that a door could meet the requirement if it is a glass door rather than a solid door.
402.2	New	There was concern that this would not interact well with existing structures as making changes could be near impossible.	Staff recommends to adopt as written. The comments from the citizens group we are not in agreement with as compliance of this code can easily be made compliant with the methods described in 401.3.	The Board asked if there were allowances for a different type of bulb? Staff responded, yes with the equivalent illumination.
402.3	New	No comments	Staff recommends to adopt as written.	No comments.
403: Ventilation				
403.1	New	One citizen/landlord had issues with the use of habitability with regards to eviction proceedings being constrained by this word usage.	Staff recommends to adopt as written. The argument about habitability is a localized argument that needs to be addressed in civil court and leasing agreements	Staff made mention that this issue is one that is between a landlord and a tenant and not with the city.

403.2	New	No comments	**Staff recommends to adopt the following, "Every bathroom and toilet room shall comply with the ventilation requirements for habitable spaces as required by Section 403.1, except that a window shall not be required in such spaces equipped with a mechanical ventilation system. Air exhausted by a mechanical ventilation system for a bathroom or tiolet room shall be discharged either to the attic or to the outdoors and shall not be recirculated.**	The Board asked what the intent was of this change. Staff responded that the intent is that we currently allow ventilation into the attic and it is not required to be taken completely outside. This keeps the city in alignment with current practices under the current code and allows for less roof penetration. The Board also asked if there was a conflict with this language and the existing building code. Staff responded that they will match both the residential and building code at the time of adoption.
403.3	New	Citizens made a recommendation to define what the local certificate is and what it should say.	Staff recommends to adopt as written. The certificate of occupancy is defined in the adopted building code by the City and does not need to be defined in the PMC.	Staff added clarity that the certificate is standardized and the content is outlined elsewhere in the code.
403.4	New	No comments	Staff recommends to adopt as written.	No comments.
403.5	New	No comments	Staff recommends to adopt as written.	No comments.
404: Occupancy Limitations				
404.1	New	No comments	Staff recommends to adopt as written.	No comments.
404.2	New	There were concerns that this code might lead to a house being boarded up due to over occupancy. The difficulty of achieving corrections were met with resistance as widening a room may be impossible.	Staff recommends to adopt as written. With the concerns for over occupancy staff finds that the intent of this code is to ensure that rooms that are non-conforming are not used as a bedroom for safety concerns related to overcrowing, inhospitable conditions.	No comments.
404.3	New	No comments	Staff recommends to adopt as written.	No comments.

404.4	New	Code 404.4 through 404.4.5 were discussed as one section. Citizens had concerns about the government's role and shouldn't be involved in the location of bathrooms. Others countered that this was known when the place was purchased or moved into and was residence decision was made by the resident. Others agreed with the first sentence but disagreed with the second. Other concerns were also raised about the selling of older houses may become impossible due to so many changes over time.	Staff recommends to adopt as written.	No comments.
404.4.1	New		Staff recommends to adopt as written. The size of rooms is intended to provide safety for occupants and rooms smaller than these sizes would lead to difficulty moving around in a situation such as a fire.	No comments.
404.4.2	New		Staff recommends to adopt as written.	No comments.
404.4.3	New		Staff recommends to adopt as written. Few instances would occur where bathrooms are not on the same floor or adjacent floors which would require a building to have at least three stories or a situation with a single bathroom off of a master bedroom. Failure to meet these requirements would lead to a quality of life issues.	No comments.
404.4.4	New		Staff recommends to adopt as written.	No comments.
404.4.5	New		Staff recommends to adopt as written.	No comments.

404.5	New	Some citizens raised concerns about the areas being to large. Others also were concerned that the definition of dining & living room was not clear enough. One recommendation that was well received by the group was to add an exception if the house was maintained in it's original configuration. One citizen had concerns that without this regulation there would be no occupancy limits.	Staff recommends to adopt as written as the intent of these codes is to ensure livability and quality of life in the community. Staff finds that dining & living rooms are commonly understood terms and do not need to be defined seperately. With regards to the exception the intent of this code is to avoid overcrowding which results in a life/safety issue. These limits would restrict how many people are permitted to live on a property and older properties that are small would likely mean that fewer people would be able to live at that property or would need to comply with the efficiency unit standards.	No comments.
404.5.1	New	No comments	Staff recommends to adopt as written.	No comments.
404.5.2	New	No comments	Staff recommends to adopt as written.	No comments.
404.6	New	One citizen's recommendation was that this should be struck as the residential code doesn't permit efficiency units. Questions were raised as to if this would cover hotel/motel units but no suggestion. In general there was confusion about what this code applied to.	Staff recommends to adopt as written. Hotel & motel units fall under a different type of occupancy and do not fall under this type of code. The IRC doesn't bar the placement of efficiency units, it does not define what they are therefore this code may still be enforced on an existing structure.	No comments.
404.7	New	No comments	Staff recommends to adopt as written.	No comments.
Chapter 5 - Plumbing Facilities and Fixture Requirements				
501: General				
501.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
501.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
502: Required Facilities				
502.1	Mod.	No comments	Staff recommends to adopt as written.	No comments.

502.2	New	No comments	Staff recommends to adopt as written.	No comments.
502.3	New	No comments	Staff recommends to adopt as written.	No comments.
502.4	New	No comments	Staff recommends to adopt as written.	No comments.
502.4.1	New	No comments	Staff recommends to adopt as written.	No comments.
502.5	New	There were concerns raised if the health department already covers some of these items and that it may not belong in the property maintenance code. There were other concerns about people having to walk through a kitchen to reach a bathroom in the back. Several had concerns about the second sentence and that it should either be removed or left as a decision to the business. Other concerns were raised that this may require an office that doesn't normally open to the public to supply public bathrooms. There were some concerns about the phrasing throughout that may lead to poor enforcement. The last recommendation was to pass a seperate ordinance requiring public access rather than as part of this code.	Staff's response to citizen's concerns: 1) Health codes check for the presence of features such as running water, the PMC is intended to check to ensure the maintainence and cleanliness of these features therefore the two codes are not the same. 2) Staff interprets that in the instance that a bathroom is in the back would be interpretted as a bathroom not for public use and modifications of buildings is not required by this code. 3) Have Law weigh in on this item? 4) Staff see's keyed controlled access as not a public bathroom and would not interpret that situation as a compliance issue. 5) Staff disagrees with needing a seperate ordinance for this specific of an item. Staff therefore recommends to adopt as written.	No comments.
503: Toilet Rooms				
503.1	New	Some citizens raised concerns that this could be applied to a residential property.	Staff recommends to adopt as written. Staff finds that this code should be applied to residential properties along with all other properties in the city.	No comments.
503.2	New	No comments	Staff recommends to adopt as written.	No comments.
503.3	New	Some raised concerns that 500 ft. was to far for spacing of bathrooms.	Staff recommends to adopt as written. 500 ft. is consistent with the IBC	No comments.

503.4	New	No comments	Staff recommends to adopt as written.	No comments.
504: Plumbing Systems and Fixtures				
504.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
504.2	New	Concerns were raised that "adequate" was unclear and should either be removed or clearly defined. Others suggested that hard numbers needed to be applied.	Staff recommends to adopt as written. Adequate is interpretted as "the ability to" clean which would mean that inadequacy means that something cannot be cleaned which would result in adverse conditions which is the intent the PMC is trying to address.	No comments.
504.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
505: Water System				
505.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
505.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
505.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
505.4	New	Citizens continued concerns about the use of adequate as being to vague. Others were worried that no mention of expansion tanks was made and that there were no requirements.	Staff believes that adequate is properly used here as defining every facility type and required usage would not encompass all possible scenarios therefore the codes official needs the discretion allowed by this word to apply the code in a reasonable manner. Staff interprets "Water heating facilities" as inclusive of an expansion tank if one is present. Staff recommends to adopt as written.	The Board said that this was required today and that there are no permits or inspections required or performed at this time.
505.5	New	No comments	Staff recommends to adopt as written.	No comments.
505.5.1	New	No comments	Staff recommends to adopt as written.	No comments.
506: Sanitary Drainage System				
506.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
506.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.

506.3	New	There were concerns of a lack of a backflow preventer for a commercial property. Also code official was not italicied was identified as a formatting error.	There was a misunderstanding of the group of the placement of a backflow preventer that doesn't apply to this type of code. The intalicied issue was a difference between the hard copy book and the electronic version, the hard copy is correctly marked. Staff recommends to adopt as written.	No comments.
507: Storm Drainage				
507.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
Chapter 6 - Mechanical and Electrical Requirements				
601: General				
601.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
601.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
602: Heating Facilities				
602.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
602.2	Cur.	A recommendation was made to add the phrase "to furnish a means to provide heat" or "heating equipment".	Staff finds that not determining a minimum level of heat provided does not address the situation of a lack of heating equipment (ie. A candle heats but not sufficiently). Staff recommends to adopt as written.	No comments.
602.3	Cur.	Concerns were voiced about what the dates would be but no suggestions were given. Some concerns were also given on if the requirement to provide heating equipment and the lease requirements and who would is responsible for payment (renter/landlord). Finally another suggestion was to simply require something to heat that is adequate for the space to leave the options open.	**Staff recommends to strike this section. The requirements for heat listed on 602.2 would provide enough means to enforce a situation where heat wasn't provided and the additional details in section 602.3 would contribute to staff potentially mediating a tenant/landlord dispute.**	The Board agreed with staff's recommendation to strike this section of code.

602.4	Cur.	One suggestion was to remove the dates.	**Staff agrees and recommends to strike the dates out of this code.**	The Board agreed with staff's recommendation to strike this section of code.
602.5	Cur.	No comments	Staff recommends to adopt as written.	No comments.
603: Mechanical Equipment				
603.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
603.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
603.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
603.4	Cur.	No comments	Staff recommends to adopt as written.	No comments.
603.5	New	No comments	Staff recommends to adopt as written.	No comments.
603.6	Cur.	No comments	Staff recommends to adopt as written.	No comments.
604: Electrical Facilities				
604.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
604.2	Mod.	No comments	Staff recommends to adopt as written.	No comments.
604.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
604.3.1	New	No comments	Staff recommends to adopt as written.	No comments.
604.3.1.1	New	No comments	Staff recommends to adopt as written.	No comments.
604.3.2	New	No comments	Staff recommends to adopt as written.	No comments.
604.3.2.1	New	No comments	Staff recommends to adopt as written.	No comments.
605: Electrical Equipment				
605.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
605.2	New	No comments	Staff recommends to adopt as written.	No comments.
605.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
605.4	New	No comments	Staff recommends to adopt as written.	No comments.
606: Elevators, Escalators and Dumbwaiters				
606.1	Mod.	No comments	Staff recommends to adopt as written.	No comments.
606.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
607: Duct Systems				
607.1	New	No comments	Staff recommends to adopt as written.	No comments.
Chapter 7 - Fire Safety Requirements				
Note: The majority of this section of code comes from the adopted international fire code which is in the process of being adopted.				
701: General				
701.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
701.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.

702: Means of Egress				
702.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
702.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
702.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
702.4	Cur.	No comments	Staff recommends to adopt as written.	No comments.
703: Fire-Resistance Ratings				
703.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
703.2	Cur.	Recommendation that "unsafe conditions" should be defined. Another questioned if we had section 111.1.1 adopted elsewhere in ordinance than this wouldn't be required. Suggestion to move language in section 111.1.1 from IFC and move it to section 2 of the PMC.	Staff recommends to adopt as written. Since this section is a carry over from the fire code it should remain in place for quick reference. The administrative section is adopted under the IFC which would include this section of code where it is defined.	No comments.
703.3	Cur.	Recommendation that if access to a wall is possible the label should be readily accessible. Concerns that the code isn't clear on which walls are to be inspected. Suggestion to add a restriction that this is only enforced 6 years after code adoption. Another recommendation was to require this at the time of occupancy for a business.	This section of code is adopted by the Fire Department which is adopting it as written. To remain consistent staff recommends adopting as written.	No comments.
703.3.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
703.3.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
703.4	Cur.	No comments	Staff recommends to adopt as written.	No comments.
703.4.1	Cur.	One citizen commented that the building code doesn't require these signs.	The current fire code requires these and the building code references the fire code when they are required. Therefore to remain consistent staff recommends to adopt as written.	No comments.
703.4.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
703.4.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
703.5	Cur.	No comments	Staff recommends to adopt as written.	No comments.

703.6	Cur.	Question if we should reference NFPA 80 for testing proceedures or not.	Staff's answer to the citizens question was yes we should reference it as the ICC standard practice is to reference existing standards rather than creating their own which would remain consistent with past practices. Therefore staff recommends to adopt as written.	No comments.
703.7	Cur.	The IBC doesn't reference atriums with mechanical smoke exhaust as acceptable. This code implies it would now need to be covered. The recommendation was to allow an exception for atriums or provide specific rules on what should be installed & maintained.	Under the fire code a vertical shaft is not an atrium and references elevator shafts, laundry shutes etc. Therefore the practice of the city is not to include atriums in this section of code. Staff recommends to adopt as written.	The Board mentioned that there was a section on atriums in the building code. There interpretation was that this section was directly related to atriums with a mechanical smoke exhaust.
703.8	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704: Fire Protection Systems				
704.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.1.1	Cur.	Question if there is anywhere in the codes that specify what percent of a building if modified is allowed before an entire structure is required to be brought up to current code.	There is not a specific location that sets a hard limit but rather it is left to the discretion of the fire and/or building official to decide when it is appropriate to bring the building up to current code standards. This is in chapter 11 of the fire code and chapter 34 of the building code. Therefore staff recommends to adopt as written.	Staff provided clarity that these situations are looked at on a case by case basis.
704.1.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.1.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.2.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.2.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.

704.3	Cur.	Question if it should be required to have the fire watchers notify occupants of the watch.	The fire code requires notification of the responsible person for an occupancy and it is left up to that individual to diffuse that information as they see fit. This has been consistent with past practices of the fire department. Staff recommends to adopt as written.	No comments.
704.3.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.4	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.4.1		There were concerns about the use of the word "unlawful" as the consequences are unclear.	Chapter 1 of the fire code and chapter 13 of the municipal code defines the consequences which in this case would be a citation. Staff recommends to adopt as written.	No comments.
704.4.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.4.3		Concerns that this code does not require approval from the building official. It also does not provide a range for time of notice which the citizens thought should be specified.	The building code is concerned with applying the codes at the time of an inspection but does not continue to inspect after occupancy and rather it is up to the fire department for enforcement. The fire code currently requires systems to be non-functional for up to 4 hours without providing notification. Therefore staff recommends to adopt as written.	No comments.
704.5	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.5.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.5.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.6	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.6.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.6.1.1	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.6.1.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.6.1.3	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.6.1.4	Cur.	No comments	Staff recommends to adopt as written.	No comments.

704.6.2	Cur.	There were concerns that the first exception is unclear.	The Fire Department would not require an interconnected system if the existing system was not. Major modifications would need to be brought up to existing code which could result in this change but would be at the discretion of the building and/or fire official to determine. Staff recommends to adopt as written.	No comments.
704.6.3	Cur.	Recommendation was made to strike exception 1 because the power source is in the main comment. Some disagreed with this recommendation.	Staff finds that listing the exception clearly and plainly provides value and close a potential gap in code coverage. Staff recommends to adopt as written.	No comments.
704.6.4	Cur.	No comments	Staff recommends to adopt as written.	No comments.
704.7	Cur.	Concerns that the responsibility of the tenant is not clear and what happens in the event of failure.	Staff interprets that the decision between tenants and landlords for responsibility falls on the terms of a lease and is not a code issue. The landlord would still be responsible for maintaining a safe environment. Staff recommends to adopt as written.	No comments.
705: Carbon Monoxide Alarms and Detection				
705.1	Cur.	Question as to why the code doesn't identify the specific location that carbon monoxide detectors should go. It isn't defined like the fire detectors.	Carbon monoxide detectors need to follow the manufacturers recommendations for installation. Staff recommends to adopt as written.	No comments.
705.2	Cur.	No comments	Staff recommends to adopt as written.	No comments.

2018 International Property Maintenance Code

LEE'S SUMMIT
MISSOURI

Yours Truly

Background

- Code Enforcement/Property Maintenance
- Reactive Enforcement
- 4 NHS Officers/65.87 square miles
- Our Goal Compliance/Abatement Not Court
- “Shrink The Box” Approach

Background

- Chap 16, UDO, Storm Water PP, Solid Waste PP, CIAA
- Last Updated In 2000
- Current Code Based On 2000 IPMC

Goals with Adoption

- Update existing code to address modern conditions
- Improve safety and health of property
- Maintain quality of property for businesses and residents

2018 IPMC Review Process

- City Staff Review (Spring 2018)
- Citizen Feedback Panel (June-July 2018)
- City Staff Review of Feedback (August 2018)
- Board of Appeals Review (August 2018)
- CEDC Review (Tonight)
- City Council (Estimated December 2018)
- Effective Date 4/1/19

Citizen Feedback

- Two main questions from Citizens:
  - Should the city be enforcing conditions inside a property?
  - Will enforcement officers be over zealous with enforcement?
- Overall well received

Points of Contention

- Snow and Ice removal from sidewalks (Section 302.3)
  - Not currently an ordinance
  - Mixed feedback
  - Can be required through an HoA
  - No consistency across the Metro
    - Required: Kansas City, MO, Kansas City, KS/Wyandotte County
    - Not Required: Overland Park, Olathe, Independence, Blue Springs

Points of Contention

- Maximum Grass Height (Section 302.4)
  - Currently established at 10 inches
  - No argument against that length during review
- Maintenance of Interior Surfaces (Section 305.3)
  - Heavily resisted code by citizens
  - Subjective as to when paint has “failed”
  - Staff recommends striking section

BILL NO. 18-

AN ORDINANCE REPEALING CHAPTER 16, LEE'S SUMMIT PROPERTY MAINTENANCE CODE OF THE CODE OF ORDINANCES OF THE CITY OF LEE'S SUMMIT, MISSOURI, AND ENACTING A NEW CHAPTER 16 PERTAINING TO THE SAME SUBJECT MATTER, FOR THE CITY OF LEE'S SUMMIT, MISSOURI.

WHEREAS, the 2018 Property Maintenance Code has been extensively reviewed by the Development Services Department, the Fire Department, the Board of Appeals, members of professional trade associations, members of the construction community, and the Community & Economic Development Committee; and

WHEREAS, after much technical study and ample public input, the Codes Administration Department, the Board of Appeals, and the Community & Economic Development Committee believe that it is in the best interests of the City of Lee's Summit to repeal in its entirety Chapter 16, Lee's Summit Property Maintenance Code of the City of Lee's Summit, Missouri to remain current with the most recently published International Codes, including the 2018 Property Maintenance Code, and State law; and

WHEREAS, based on staff reports and public comment, the City Council desires to protect the public health, safety, and welfare by repealing Chapter 16 and enacting a new Chapter 16 pertaining to the same subject matter; and

WHEREAS, The City of Lee's Summit pursuant to the Lee's Summit City Charter, the Missouri State Constitution, and the City's police powers has the authority to regulate for the public health, safety, and welfare;

NOW, THEREFORE, BE IT ORDAINED BY THE COUNCIL OF THE CITY OF LEE'S SUMMIT, MISSOURI, as follows:

SECTION 1. Chapter 16, Lee's Summit Property Maintenance Code, of the Code of Ordinances of the City of Lee's Summit, Missouri, is hereby repealed in its entirety and a new Chapter 16 is enacted, pertaining to the same subject matter, which shall be the 2018 International Property Maintenance Code as published by the International Code Council, Inc. (First Printing, August 2017, ISBN 978-1-60983-748-8), with the following changes which are shown in the strikethrough (deleted) and underline (added) format:

101.1 Title.
These regulations shall be known as the *~~International~~ Property Maintenance Code* of <u>Lee's Summit</u> hereinafter referred to as "this code."

103.5 Fees.

The fees for activities and services performed by the department in carrying out its responsibilities under this code shall be as indicated in the ~~following schedule~~ currently adopted schedule of fees.

104.3. - Search warrant. ~~Right of Entry.~~

104.3.1 Complaint. If a complaint in writing is filed by the Code Official, any police officer, City Attorney or prosecuting attorney of the City, with the Municipal Court of the City, stating that he has probable cause to believe there exists in a building or structure, more particularly described therein, a violation or violations of provisions of this chapter and is within the territorial jurisdiction of the City, and if such complaint is verified by the oath or affirmation stating evidential facts from which such judge determines the existence of probable cause, then such judge shall issue a search warrant directed to the authorized person to search the structure or premises therein described for the purposes requested. Such search warrant may be executed and returned only within ten (10) days after the date of its issuance.

104.3.2 Report. The person authorized to search shall make a return promptly after concluding the search, and such return shall contain an itemization of all violations of this chapter discovered pursuant to such search. Refusal to allow entry upon presentation of a search warrant shall be an ordinance violation.

104.3.3 Execution. Execution of a search warrant issued under this section shall not be by forcible entry.

~~Where it is necessary to make an inspection to enforce the provisions of this code, or whenever the *code official* has reasonable cause to believe that there exists in a *structure* or upon a *premises* a condition in violation of this code, the *code official* is authorized to enter the structure or *premises* at reasonable times to inspect or perform the duties imposed by this code, provided that if such *structure* or *premises* is occupied the *code official* shall present credentials to the *occupant* and request entry. If such structure or *premises* is unoccupied, the *code official* shall first make a reasonable effort to locate the *owner*, owner's authorized agent or other person having charge or control of the *structure* or *premises* and request entry. If entry is refused, the *code official* shall have recourse to the remedies provided by law to secure entry.~~

106.4 Violation Penalties. Any person convicted of a violation of this Property Maintenance Code shall be punished for that violation by a fine of not less than fifty dollars ($50.00), but not more than five hundred dollars ($500.00), or by imprisonment of not more than ninety (90) days, or by both such fine and imprisonment. Whenever the penalty is to be a fine or a fine and imprisonment, the fine shall be not less than the minimum amount set out in the following schedule:

106.4.1 First offense ..... $ 50.00

106.4.2 Second offense .$ 100.00

106.4.3 Third offense .....$ 300.00

106.4.3. Fourth and subsequent offenses ..... $ 500.00

106.4.4 Reoccurring Offense. In determining the applicable minimum fine, an offense shall be considered a recurring offense only if the defendant has previously pleaded guilty of violating the same minimum standard at the same location.

~~Any person who shall violate a provision of this code, or fail to comply therewith, or with any of the requirements thereof, shall be prosecuted within the limits provided by state or local laws. Each day that a violation continues after due notice has been served shall be deemed a separate offense.~~

106.6 Extension of time to perform work. Upon receipt of an application from the person required to conform to the order and by agreement of such person to comply with the order if allowed additional time, the Codes Official may grant an extension of time, not to exceed an additional one hundred twenty (120) days, within which to complete said repair, rehabilitation or demolition, if the Codes Official determines that such an extension of time will not create or perpetuate a situation imminently dangerous to life or property. The Codes Official's authority to extend time is limited to the physical repair, rehabilitation or demolition of the premises and will not in any way affect the time to appeal the notice and order pursuant to Division 11 of this article.

~~SECTION 112~~
~~STOP WORK ORDER~~

~~[A] 112.1 Authority.~~
~~Whenever the *code official* finds any work regulated by this code being performed in a manner contrary to the provisions of this code or in a dangerous or unsafe manner, the *code official* is authorized to issue a stop work order.~~

~~[A] 112.2 Issuance.~~
~~A stop work order shall be in writing and shall be given to the *owner* of the property, to the *owner's* authorized agent, or to the person doing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the~~

~~reason for the order and the conditions under which the cited work is authorized to resume.~~

~~**[A] 112.3 Emergencies.**~~
~~Where an emergency exists, the *code official* shall not be required to give a written notice prior to stopping the work.~~

~~**[A] 112.4 Failure to comply.**~~
~~Any person who shall continue any work after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be liable to a fine of not less than **[AMOUNT]** dollars or more than **[AMOUNT]** dollars.~~

302.2 Grading and drainage. Drainage of roofs and paved areas, yards and courts, and other open areas on the premises shall not be discharged in a manner that creates a public nuisance. ~~*Premises* shall be graded and maintained to prevent the erosion of soil and to prevent the accumulation of stagnant water thereon, or within any structure located thereon.~~

~~**Exception:** *Approved* retention areas and reservoir.~~

302.2.1. - Drainage regulations. *Minimum standards:* All drainage facilities shall be designed to carry waters to the nearest drainage way, storm sewer conveyance, or other approved point of collection and conveyance. Erosion of ground in the area of discharge shall be prevented by installation of erosive control devices. Unless specified drainage ways and swales are specifically approved by the Code Official, abutting property lines between dwellings shall be designed to function as drainage ways. The toe of slopes shall set back from the property line a minimum of one-foot. The area surrounding the building foundation shall have a drainage gradient as provided for in the International Residential Code or International Building Code, as amended from time to time.

302.2.2. Prohibited conduct. No person shall allow or cause any:

A. Obstruction to be created, installed or maintained within any drainage way, detention facility, or engineered swale which will create ponding on adjacent property, divert water onto the adjoining property, or impede drainage. Fences may be erected in such areas provided they do not unnecessarily restrict the flow of water.

B. Water from intermittent sources such as discharges from sump pumps, downspouts, foundation drains, swimming pools, swimming pool backwashes, or other similar sources excluding lawn sprinklers to be discharged closer than: Five (5) feet to any adjoining property line.

1. Five (5) feet to any adjoining side or rear property line(s).
2. The platted right-of-way line where no public sidewalk or paved pedestrian walkway exists unless specifically approved by the City Engineer.
3. Five (5) feet to any edge of a public sidewalk or paved public pedestrian walkway unless specifically approved by the City Engineer.

302.2.3. Enforcement. Where such conditions exist and the Code Official has given written notice of the violation, the owner of the property shall take appropriate measures to eliminate the problems caused on the adjacent property, within the time period stated in the notice, and failure to do so shall be a violation of this chapter.

302.3 - Sidewalks and driveways. All private sidewalks, walkways, stairs, driveways, parking spaces and similar areas shall be kept in a proper state of repairs, and maintained free from hazardous conditions. ~~Sidewalks, walkways, stairs, driveways, parking spaces and similar areas shall be kept in a proper state of repair, and maintained free from hazardous conditions.~~

Exception: Hazardous conditions created by inclement weather are not applicable to this section.

302.4 Weeds. Premises and exterior property shall be maintained free from weeds or plant growth in excess of 10”. Noxious weeds shall be prohibited. Weeds shall be defined as all grasses, annual plants and vegetation, other than trees or shrubs provided; however, this term shall not include cultivated flowers and gardens.

Upon failure of the owner or agent having charge of a property to cut and destroy weeds after service of a notice of violation, they shall be subject to prosecution in accordance with Section 106.3 and as prescribed by the authority having jurisdiction. Upon failure to comply with the notice of violation, any duly authorized employee of the jurisdiction or contractor hired by the jurisdiction shall be authorized to enter upon the property in violation and cut and destroy the weeds growing thereon, and the costs of such removal shall be paid by the owner or agent responsible for the property.

302.10. Portable Storage Containers and Roll-off Trash Containers. The provisions of this article shall apply to the location and length of use of portable storage containers and roll-off trash containers on any property used for residential purposes within the City of Lee's Summit.

302.10.1 Condition and maintenance. All portable storage containers and roll-off trash containers shall be delivered and maintained in good condition, free from rodents, insects, graffiti, vulgar and/or pornographic words or pictures. It shall be the responsibility of the property owner and the supplying company to maintain the portable storage containers or roll-off trash containers in accordance with the provisions of this article.

302.10.2 Definitions. For the purposes of this section, certain words and phrases used in this section are defined as follows:

Portable storage container means any container designed and used for the storage of personal property of a non-hazardous nature which is typically rented or leased to owners or occupants of property for their temporary use and which is typically delivered and removed by truck.

Roll-off trash container means a large container designed and used for the storage of refuse, rubbish, trash, garbage, junk, debris, offal, or any material rejected as useless and fit only to be thrown away. Such container is typically rented or leased to owners or occupants of property for their temporary use and which is typically delivered and removed by truck. This term shall not be interpreted to refer to a "trash container" or "dumpster" that is stored in a more permanent manner on the property, and is referenced and regulated by the Unified Development Ordinance, and further required to be screened from public view.

Residential purposes means structures intended as a place of residence and includes the following categories for purposes of this chapter:

One and two-family dwelling units and townhouses means structures constructed for dwelling purposes by separate families whereby each dwelling unit extends from foundation to roof and with open space on at least two (2) sides.

Apartment and multi-family complexes means structures constructed for dwelling purposes by two (2) or more families whereby dwelling units do not extend from foundation to roof.

302.10.3 Placement. Portable storage containers shall not be placed on public property or within the City's right-of-way. All portable storage containers shall be placed on a paved surface and be located a minimum of eleven (11) feet behind the edge of street or alley curb, or the edge of street pavement or alley in the case that no curb exists. The placement of portable storage containers shall not encroach onto adjoining properties and shall not block or hinder access to or from emergency escape and rescue openings.

> **Exception:** Should existing site conditions not allow for the placement of a portable storage container in full compliance with these provisions, exceptions may be considered and written approval granted on a case by case basis by the Director of Codes Administration. The Director of Codes Administration shall solicit input from the Director of Public Works and the Fire Chief prior to granting such approval.

302.10.4 Roll-off trash containers. The placement of roll-off trash containers shall not encroach onto adjoining properties and shall not block or hinder access to or from emergency escape and rescue openings. Roll-off trash containers shall not be stored in buildings or placed within five (5) feet of combustible walls, openings or combustible roof eave lines. Unless otherwise permitted by law, roll-off trash containers shall not be located in any part of the City's right-of-way whether improved or unimproved, except by written approval of the Public Works Director.

302.10.5 Duration.

1. Portable storage containers may be stored on the property for a period up to fourteen (14) days, and be allowed up to three (3) nonconsecutive times in a one (1) year period.
2. Roll-off trash containers may be stored on the property as follows:
   A. For one and two-family dwelling units and townhouses, roll off trash containers may be stored on the property for a period up to fourteen (14) days, and be allowed up to three (3) nonconsecutive times in a one (1) year period.
   B. For apartment and multi-family complexes, roll off trash containers may be stored on the property in accordance with the following:
      i. One occurrence per month for a period not to exceed six (6) days per occurrence;
      ii. Two (2) occurrences per month not to exceed three (3) days per each occurrence;
      iii. In the event that a roll off trash container is needed on site beyond six (6) days per month, a written request shall be made to the Code Official for

consideration. Said request shall be submitted and approval granted prior to the continued presence of the roll off trash container beyond the allowable six (6) days per month.

iv. The presence of roll off trash containers on a property shall be limited to seventy-two (72) days within a one year period. The Code Official has the administrative authority to approve the presence of roll off trash containers on a property for a period not to exceed ninety (90) days within a one (1) year period. Each day a roll off trash container is present on the property, whether in violation or not, shall be considered toward the total number of days allowed within a one (1) year period.

3. Exceptions:

A. When being used in conjunction with a construction project that has a valid building permit.

B. When the Mayor has declared the City or portion thereof a disaster area.

C. When being used in conjunction with an approved special use or special event permit.

302.11 Donation Bins. It is the purpose and intent of the Lee's Summit City Council, through the adoption of this article, to establish regulations relating to the placement of donation bins within the City in order to:

1. Promote the community's health, safety, and welfare by regulating unattended donation bins for clothing or other salvageable personal property within the City;
2. Help ensure that donation bins do not pose a hazard to pedestrian and vehicular traffic;
3. Help ensure that material is not allowed to accumulate outside of the donation bins where it can be scattered by adverse weather conditions, animal contacts and human activities;
4. Help ensure that donation bins soliciting donations on the basis of charitable benefit are actually related to the stated charitable benefit; and
5. Establish criteria that avoid attracting vermin, unsightliness, and public health hazard.

302.11.2. Definitions. The following words, terms and phrases, when used in this article, shall have the meanings ascribed to them below. Where terms are not defined in this article, but are defined in other provisions of the Code of Ordinances, such terms shall have the meaning ascribed to them as in those ordinance provisions, unless the context clearly provides otherwise. All other undefined terms shall have ordinarily accepted meanings as the context implies.

Donation bin means any portable receptacle or container made of metal, steel or any other material designed or intended for the collection and temporary storage of donated clothing or other salvageable personal property. This term does not include recycle bins for the collection of recyclable materials governed or regulated by the City's Unified Development Ordinance.

Operator means the "operator" of the donation bin is the individual or organization owning the bin and placing it on private property for the public to use for the donation of used clothing or other salvageable personal property, regardless of whether such operator is also the holder of a donation bin permit for the subject donation bin.

302.11.3 Generally.

1. *Non-profit requirement.* Donation bins shall only be allowed if the donations they receive are used for the benefit of a valid and duly organized non-profit organization.
2. *Location.*
    - A. Donation bins shall only be located on: private property zoned as commercial or industrial as defined by the Unified Development Ordinance; or property containing institutional uses such as schools, churches/religious assembly, and similar community services in any zoning district.
    - B. Donation bins shall be located on hard surface pavement or concrete pad or sidewalk adjacent to a building without interfering with pedestrian movement or traffic circulation.
    - C. Donation bins are prohibited:
        - i. On vacant parcels of land and parcels containing vacant/unoccupied buildings.
        - ii. In parking spaces or drive aisles.
        - iii. Within a distance of one hundred (100) feet from any residential district or use.

302.11.4. Permit required. A donation bin permit is required to place, keep and maintain donation bins. An application for a donation bin permit shall include:

1. Name, telephone number and address of the operator of the bin, as defined above.

2. Name, telephone number and address of the non-profit organization benefited by the bin.
3. Written consent of the owner of the property where the bin is to be placed.
4. Description or site plan showing location and placement of proposed bin(s).
5. Proof of status of the non-profit organization benefited by the bin.
6. Description of the manner in which the clothing or other donations would be used, sold or distributed for the benefit of the non-profit organization.
7. The schedule for the bin to be emptied.
8. Size and photograph of the bin to be placed.

302.11.5 Number of bins*.* Only one (1) bin per property shall be permitted.

302.11.6. Labeling *located on the bin shall include:*

1. The name, phone number and address for the non-profit corporation that is benefited by the bin.
2. The name, phone number and address of the person(s) responsible for the bin placement, pick-up and emptying.
3. The name, phone number and address of the owner of the property upon which the bin is located.

302.11.7 Setbacks. Bins shall be situated so that they are located the following minimum distances ("setbacks") from adjacent property boundary lines:

1. Front: Twenty (20) feet.
2. Side: Ten (10) feet.
3. Rear: Ten (10) feet.

302.11.8 Size*.* Bins are limited to a maximum height of seven (7) feet and a ground surface area of twenty-five (25) square feet.

302.11.8 Fees*.* Fees for donation bin permits shall be as provided for in the City's Schedule of Fees and Charges.

302.11.9 Requirements for maintenance.

1. A permittee shall operate and maintain, or cause to be operated and maintained, all donation bins covered by the applicable permits in the following manner:

   A. Donation bins shall be maintained in good condition and appearance with no structural damage, holes, peeling paint, or rust and shall be free of graffiti.

   B. Donation bins shall be locked or otherwise secured.

   C. Donation bins shall be serviced and emptied as needed, but at least once per month or within forty-eight (48) hours of a request by the Director of Planning and Codes or his designee.

2. The permittee shall maintain or cause to be maintained the area surrounding the donation bins free of any junk, garbage, trash, debris or other refuse material.

3. The permittee, operator, and owner of the property on which the bins are located shall be individually and severally responsible for abating and removing all junk, garbage, trash, debris and other refuse material in the area surrounding the donation bins within twenty-four (24) hours of written notice or verbal notice from the City.

4. The permittee, operator, and owner of the property on which the bins are located shall be individually and severally responsible for all costs for abating and removing any junk, garbage, trash, debris, and other refuse material from the area surrounding the donation bins.

303.1 Swimming Pools

Swimming pools shall be maintained in a clean and sanitary condition, ~~and in good repair.~~ and all components of the pool maintained in a functioning state. Abandoned or unused swimming pools, spas, and hot tubs that do not meet these conditions may require removal at the discretion of the codes official.

304.13.2 Openable windows.
Every window, other than a fixed window, shall be easily openable~~ and capable of being held in position by window hardware~~.

~~**304.14 Insect screens.**~~
~~During the period from [DATE] to [DATE], every door, window and other outside opening required for ventilation of habitable rooms, food preparation areas, food service areas or any areas where products to be included or utilized in food for human~~

~~consumption are processed, manufactured, packaged or stored shall be supplied with approved tightly fitting screens of minimum 16 mesh per inch (16 mesh per 25 mm), and every screen door used for insect control shall have a self-closing device in good working condition.~~

~~**Exceptio**n: Screens shall not be required where other approved means, such as air curtains or insect repellent fans, are employed.~~

304.18.1 Doors.
Doors providing access to a *dwelling unit*, *rooming unit* or *housekeeping unit* that is rented, leased or let shall be equipped with a deadbolt lock designed to be readily openable from the side from which egress is to be made without the need for keys, special knowledge or effort and shall have a minimum lock throw of 1 inch (25 mm). Such deadbolt locks shall be installed according to the manufacturer's specifications and maintained in good working order. For the purpose of this section, a sliding bolt shall not be considered an acceptable deadbolt lock. Locks not conforming to the code may be accepted by review of the codes official.

~~**305.3 Interior surfaces.**~~
~~Interior surfaces, including windows and doors, shall be maintained in good, clean and sanitary condition. Peeling, chipping, flaking or abraded paint shall be repaired, removed or covered. Cracked or loose plaster, decayed wood and other defective surface conditions shall be corrected.~~

307.1 General.
Every exterior and interior flight of stairs having more than four risers shall have a handrail or guardrails as required by the building code at the time of construction or shall meet the following provision.

Every exterior and interior flight of stairs having more than four risers shall have a handrail on one side of the stair and every open portion of a stair, landing, balcony, porch, deck, ramp or other walking surface that is more than 30 inches (762 mm) above the floor or grade below shall have guards. Handrails shall be not less than 30 inches (762 mm) in height or more than 42 inches (1067 mm) in height measured vertically above the nosing of the tread or above the finished floor of the landing or walking surfaces. Guards shall be not less than 30 inches (762 mm) in height above the floor of the landing, balcony, porch, deck, or ramp or other walking surface.

Exception: Guards shall not be required where exempted by the adopted building code.

308.2 Disposal of rubbish.
~~Every *occupant* of a structure shall dispose of all *rubbish* in a clean and sanitary manner by placing such *rubbish* in *approved* containers.~~ Every occupant of a structure shall dispose of all rubbish in a clean and sanitary manner by placing such rubbish in approved containers and disposing of such rubbish in an approved disposal facility.

~~**308.2.1 Rubbish storage facilities.**~~
~~The *owner* of every occupied *premises* shall supply *approved* covered containers for *rubbish,* and the *owner* of the *premises* shall be responsible for the removal of *rubbish.*~~

308.3 Disposal of garbage.
~~Every *occupant* of a structure shall dispose of garbage in a clean and sanitary manner by placing such garbage in an *approved* garbage disposal facility or *approved* garbage containers.~~ Every occupant of a structure shall dispose of all garbage in a clean and sanitary manner by placing such garbage in approved containers and disposing of such garbage in an approved disposal facility.

Section 310

ABANDONED RESIDENTIAL PROPERTY REGISTRATION

310.1 General. It is the purpose and intent of the Lee's Summit Council, through the adoption of this section, to establish an abandoned residential property registration program for properties which are in the process of foreclosure as a mechanism to protect residential neighborhoods from becoming blighted through the lack of adequate maintenance and adequate security of abandoned properties.

310.2 Definitions. For the purposes of this section, certain words and phrases used in this section are defined as follows:

Abandoned means a property that is vacant and under a current Notice of Default or Notice of Sale, or properties that have been the subject of a foreclosure sale where the title was retained by the beneficiary of a deed of trust involved in the foreclosure and any properties transferred under a deed in lieu of foreclosure or sale.

Accessible property means a property that is accessible through a compromised, breached or broken gate, fence or other entry point.

Accessible structure means a structure that is unsecured or breached in such a way as to allow access to the interior space by unauthorized persons.

Beneficiary means a lender under a note secured by a deed of trust.

Days means consecutive calendar days.

Deed in lieu of foreclosure or sale means a recorded document that transfers ownership of a property from the trustor to the holder of a deed of trust upon consent of the beneficiary of the deed of trust.

Deed of trust means an instrument by which title to real estate is transferred to a third party trustee as security for a real estate loan. This definition includes any subsequent deeds of trust.

Default means the failure to fulfill a contractual obligation, monetary or conditional.

Evidence of vacancy means any condition that on its own, or combined with other conditions present, would lead a reasonable person to believe that the property is vacant. Such conditions include but are not limited to, overgrown or dead vegetation, accumulation of newspapers, circulars, flyers or mail, past due utility notices or disconnected utilities, accumulation of trash, junk or debris, the absence of window coverings such as curtains, blinds or shutters, the absence of furnishings or personal items consistent with residential habitation, statements by neighbors, passersby, delivery agents, government employees that the property is vacant.

Foreclosure means the process by which a property, placed as security for a real estate loan, is sold at auction to satisfy the debt if the trustor (borrower) under a deed of trust defaults.

Local means within forty (40) road/driving miles distance of the subject property.

Notice of default means a notice, issued pursuant to the applicable real estate security document or Section 408.554, RSMo, that a default has occurred under a deed of trust.

Out of area means in excess of forty (40) road/driving miles distance of the subject property.

Owner means any person, co-partnership, association, corporation, or fiduciary having a legal or equitable title or any interest in any real property.

Owner of record means the person having recorded title to the property at the point in time the record is provided by the Jackson County or Cass County Recorders Office.

Property means any unimproved or improved real property, or portion thereof, situated in the City and includes the buildings or structures located on the property regardless of condition.

Registered Representative means the person designated by a beneficiary as the beneficiary's representative for purposes of accepting notice, service and summons on behalf of the beneficiary and for otherwise ensuring compliance with the requirements of this article.

Residential building means any improved real property, or portion thereof, situated in the City, designed or permitted to be used for dwelling purposes, and shall include the buildings and structures located on such improved real property. This includes any real property being offered for sale, trade, transfer, or exchange as "residential" whether or not it is legally permitted or zoned for such use.

Securing means such measures as may be directed by the Director of Codes Administration or his designee that assist in rendering the property inaccessible to unauthorized persons, including but not limited to the repairing of fences and walls, chaining/pad locking of gates, the repair or boarding of door, window or other openings.

Trustee means the person, firm or corporation holding a deed of trust on a property.

Trustor means a borrower under a deed of trust, who deeds property to a trustee as security for the payment of a debt.

Vacant means a building/structure that is not legally occupied.

310.3. Registration.

1. Any beneficiary under a deed of trust covering a property located within the City of Lee's Summit shall cause an inspection to be performed of the property that is the security for the deed of trust within fifteen (15) days of issuing a notice of default to the trustor. If the property is found to be vacant or shows evidence of vacancy, it is, by this article, deemed abandoned and the beneficiary shall, within ten (10) days of the inspection, register the property with the Director of Codes Administration or his designee on forms provided by the City.
2. The registration shall contain the full legal name of the beneficiary and the registered representative, the direct street/office mailing address of the beneficiary and the registered representative (no P. O. Boxes), a direct contact name and phone number for the beneficiary and registered representative, and, if applicable, the local property management company responsible for the security, maintenance and marketing of the property.
3. The registration shall be valid as long as the subject property remains vacant and shall be amended as needed.
4. This section shall also apply to properties that have been the subject of a foreclosure sale where title to the property was transferred to the beneficiary of a deed of trust involved in the foreclosure and any properties transferred under a deed in lieu of foreclosure or sale.
5. Properties subject to this article shall remain under the security and maintenance standards of this section as long as they remain vacant.

6. Any person, firm or corporation that has registered a property under this article must report any change of information contained in the registration within ten (10) days of the change.

310.4. Maintenance requirements. Properties subject to this article shall be in compliance with the Lee's Summit Property Maintenance Code. Adherence to this section does not relieve the beneficiary or property owner of any obligations set forth in any covenants conditions and restrictions or homeowners association rules and regulations which may apply to the property.

310.5. Security requirements.

1. Properties subject to this section shall be maintained in a secure manner so as not to be accessible to unauthorized persons. This includes, without limitation, the closure and locking of windows, doors (walk-through, sliding and garage), gates and any other opening of such size that it may allow a child to access the interior of the property and/or structure(s). In the case of broken windows "securing" means the reglazing or boarding of the window.
2. If the beneficiary is an out of area beneficiary, a local property management company shall be contracted to perform weekly inspections to verify that the requirements of this section, and any other applicable laws, are being met.
3. The beneficiary shall cause the property to be inspected on a weekly basis to determine if the property is in compliance with the requirements of this article.

310.6. Compliance with other authority. The requirements of this article are in addition to any other maintenance and security measures required by the Code of Ordinances. The requirements of this article shall not serve to lessen or abrogate any other applicable provisions of the Code of Ordinances.

310.7 Violations. Any beneficiary, registered representative, or local property management company that violates any provision of this article shall be in violation of this article, and summons may be issued against the beneficiary's representative for such violation. In addition to any other penalties which may be assessed for a violation of this article, any person or entity who violates a provision of this article shall be assessed a fine of five hundred dollars ($500.00) per violation.

401.3 Alternative devices.
In lieu of the means for natural light and *ventilation* herein prescribed, artificial light or mechanical *ventilation* complying with ~~the~~ ~~*International Building Code*~~ adopted codes shall be permitted.

402.1 Habitable spaces.
Every *habitable space* shall have not less than one window or glazed door of *approved* size facing directly to the outdoors or to a court. The minimum total glazed area for every *habitable space* shall be 8 percent of the floor area of such room. Wherever walls or other portions of a structure face a window of any room and such obstructions are located less than 3 feet (914 mm) from the window and extend to a level above that of the ceiling of the room, such window shall not be deemed to face directly to the outdoors nor to a court and shall not be included as contributing to the required minimum total window area for the room.

Exception: Where natural light for rooms or spaces without exterior glazing areas is provided through an adjoining room, the unobstructed opening to the adjoining room shall be not less than 8 percent of the floor area of the interior room or space, or not less than 25 square feet (2.33 m2)**,** whichever is greater. The exterior glazing area shall be based on the total floor area being served.

~~**602.3 Heat supply.**~~
~~Every *owner* and *operator* of any building who rents, leases or lets one or more *dwelling units* or *sleeping units* on terms, either expressed or implied, to furnish heat to the *occupants* thereof shall supply heat during the period from **[DATE]** to **[DATE]** to maintain a minimum temperature of 68°F (20°C) in all habitable rooms, *bathrooms* and *toilet rooms*.~~

~~**Exceptions:**~~
~~1. When the outdoor temperature is below the winter outdoor design temperature for the locality, maintenance of the minimum room temperature shall not be required provided that the heating system is operating at its full design capacity. The winter outdoor design temperature for the locality shall be as indicated in Appendix D of the *International Plumbing Code*.~~
~~2. In areas where the average monthly temperature is above 30°F (-1°C), a minimum temperature of 65°F (18°C) shall be maintained.~~

602.4 Occupiable work spaces.

Indoor occupiable work spaces shall be supplied with heat ~~during the period from **[DATE]** to **[DATE]**~~ to maintain a minimum temperature of 65°F (18°C) during the period the spaces are occupied.

Exceptions:
1. Processing, storage and operation areas that require cooling or special temperature conditions.
2. Areas in which persons are primarily engaged in vigorous physical activities.

SECTION 2. It is the intention of the City Council and it is hereby ordained that the provisions of this ordinance shall become and be made a part of the Code of Ordinances for the City of Lee's Summit, Missouri, and shall be codified in Chapter 16 with such changes to the International Property Maintenance Code as set forth above.

SECTION 3. This ordinance shall be in full force and effect on April 1, 2019 after the date of its passage and adoption, and approval by the Mayor.

SECTION 4. That if any section, subsection, sentence, clause, phrase or portion of this Ordinance is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such portion shall be deemed a separate and independent provision and such holding shall not affect the validity of the remaining portions thereof.

PASSED by the City Council of the City of Lee's Summit, Missouri, this ________day of ____________________________, 2018.

____
Mayor *William A. Baird*

ATTEST:

____
City Clerk *Trisha Fowler Arcuri*

APPROVED by the Mayor of said city this _____ day of ____________________, 2018.

____
Mayor *William A. Baird*

ATTEST:

____
City Clerk *Trisha Fowler Arcuri*

APPROVED AS TO FORM:

____

City Attorney *Brian W. Head*

Packet Information

File #: 2018-2408, **Version:** 1

Application #PL2018-194 Unified Development Ordinance Amendment #3 - Article 6 Use Standards - Accessory Uses and Structures - Table 6.IV-1. Accessory Structures - Amending Detached Garage Size Limitations in All Residential Districts; City of Lee's Summit Applicant

Staff received a request from a home owner to construct a detached garage on a lot exceeding 1 acre in size. The current conditions provide a formula allowing a detached garage of 250 sq. ft. for every 5,000 sq. ft. of lot area up to a maximum of 1,000 sq. ft. for lots less than 4 acres and 2,000 sq. ft. for lots of 4 acres or more. The requestor was looking to construct a 3 car detached garage of 1,500 sq. ft. but was limited to a maximum of 1,000 sq. ft. per the formula. The proposed amendment would still utilize the formula but increase maximum allowable square footage of a detached garage to 2,500 sq.ft. on residentially zoned lots of 5 acres or less. Lots in excess of 5 acres would have a maximum of 3,500 sq. ft.

This proposed amendment would allow large lot owners the option to construct larger garages for vehicles or necessary maintenance equipment. Again the current formula stays in place while providing increased maximum size limitations. Agricultural zoning does not have a size limitation which is appropriate for the size of lots in that district.

Proposed Council Motion: I move that Application #PL2018-194 Unified Development Ordinance Amendment #3 - Article 6 Use Standards - Accessory Uses and Structures - Table 6.IV-1. Accessory Structures - Amending Detached Garage Size Limitations in All Residential Districts be forwarded to the Planning Commission for consideration.

Recommendation: Staff recommends forwarding this proposed amendment on to the Planning Commission for public hearing.

Presenter: Robert McKay, AICP, Director of Planning and Special Projects

Sec. 6.1480. - Prohibited accessory uses and structures.

The following accessory uses and structures are specifically prohibited:

A. Automotive repair in residential districts except for personal vehicles being repaired inside a garage.

B. Hog lots.

C. Livestock commercial feed lots.

D. Detached carports except when specifically approved as part of a preliminary development plan for a multi-family development.

E. Outdoor vending machines, except for:

1. Certain outdoor vending machines that are accessory to financial institutions, such as ATM's, self-service car wash business dispensers offering such items as cleaners, waxes and towels for vehicle washing and similar accessory uses and structures approved by the Director. Such accessory vending machines shall be attached to or built into exterior walls of the commercial business or integrated into a drive island, and

2. Mobile food vending regulated in Division V of this article.

Note: Retail sales of products being displayed outdoors, provided such products are being sold within the commercial building where the products are being displayed shall not constitute an accessory use or structure. Said outdoor product display shall be located immediately adjacent to the wall of the building or within 20 feet of such wall, or in the case of a C-Store adjacent to the pump island, except for seasonal sales regulated by Division V of this article.

Table 6.IV-1. Accessory Structures

Accessory Structure	Permitted Zoning Districts	Required Setbacks	Height	Size Limitations and Other Special Conditions Note: See Section 6.1330.B. for easement and right-of-way encroachments
Arbor	Residential (including AG, RDR and RLL)	None	10 feet	Not to impair sight triangle.
Carport — Attached to Principal Structure	Residential (including AG, RDR and RLL)	Same as zoning district for principal structure	Not to exceed height of structure to which attached	Maximum Size: 250 square feet, not to exceed structure to which attached.
Carport — Attached to	Residential	Same as	Not to exceed	Maximum Size: 250

Fence or Wall — Other	CP-1, CP-2, CS and PI	0 feet	8 feet	All fence or walls shall be located out of the sight triangle. A fence or wall shall be constructed with a finished side facing outward from the property.
Fence — Tennis Court	All	Front: Prohibited Side: 10 feet Rear: 10 feet	12 feet	
Flag Pole	All	Front: 10 feet Side: 10 feet Rear: 10 feet	25 feet	
Garage in AG — Detached	AG	Front: Prohibited Side: 35 feet Rear: 35 feet	40 feet (maximum height in district)	No limitation on size in AG.
Garage — Detached	All Residential districts (including RDR and RLL, but excluding AG)	Front: No closer than principal structure Side: 10 feet Rear: 10 feet (4 feet for alley access); 30 feet for detached garage with loft residential dwelling unit	25 feet (not to exceed height of principal structure on property)	Detached garage shall not exceed 250 square feet for each 5,000 square feet of lot area, with a maximum of ~~1,000~~ 2,500 square feet for lots less than 5 4 acres, and a maximum of ~~2,000~~ 3,500 square feet for lots of 5 4 acres or more. Only one garage structure is permitted. Design and construction shall be as set forth in Section 6.1350.E.