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ENGINEERING EXAMINATION and ANALYSIS REPORT #1

File No: 4874-0701

Prepared for:
Maricopa County Sheriff's Office
Attn: Lt. David Toporek

Date of Incident:	June 19, 2014
Location of Incident:	15723 E. Appleby Road, Gilbert, AZ 85298
MCSO Case:	IR 14-014274

Dates of Examinations:
Scene Examination: July 9, 2014

CONTENTS:

The investigation activities and reporting have been conducted in accordance with the following standards among others:

- NFPA 921-2011 Edition "Guide for Fire and Explosion Investigations"
- ASTM E620–04 "Standard Practice for Reporting Opinions of Scientific or Technical Experts"
- ASTM E678–07 "Standard Practice for Evaluation of Scientific or Technical Data"
- ASTM E860–07 "Standard Practice for Examining And Preparing Items That Are Or May Become Involved In Criminal or Civil Litigation"
- ASTM E1020–96 (Reapproved 2006) "Standard Practice for Reporting Incidents that May Involve Criminal or Civil Litigation"
- ASTM E1188–05 "Standard Practice for Collection and Preservation of Information and Physical Items by a Technical Investigator"
- ASTM E2332–04 "Standard Practice for Investigation and Analysis of Physical Component Failures"

(A) SUMMARY:

The reported damage to the circuit caused by the dog chewing on the romex at the receptacle circuit could not have possibly caused any interruption of the west HVAC system operation.

The electrical systems of the home were found to be in serviceable condition with no anomalies.

The west HVAC system was inadequate and improperly configured for this type of utilization of the "dog room". This inadequate condition was exacerbated by the airflow limitations with the closed room and fact that the HVAC system was neglected as to maintenance including the most basic requirement of changing the filter.

A plugged return filter will cause a number of problems with an HVAC unit besides poor airflow and poor cooling, including the very likely condition of freezing up the indoor coil (evaporator coil) which will block all the airflow and render the unit completely ineffective.

Even if the west HVAC unit did not freeze up, clearly there would not be sufficient airflow to cool the animals and likely not enough turnover of the air to replenish the oxygen as needed.

(B) ENCLOSURES:

1. 31 color images of evidence examination (from digital photographs) with descriptions.

(C) INSTRUCTIONS:

Instructions were received from Lt. David Toporek representing Maricopa County Sheriff's Office for George J. Hogge PE, Principal Electrical Engineer to conduct the following Forensic Engineering Examinations and Activities:

- Forensic Engineering evaluation of the house electrical systems to confirm or negate any electrical or mechanical failure that could have contributed to or caused the HVAC system to fail on the residence.

- Forensic Engineering examination of the HVAC system(s) serving the home, focusing on the efficacy and functionality of the HVAC system serving the room that the dogs were found in.

- Survey and take samples of the insulation associated with the room the dogs had been found in.

- Collect and analyze the circuit conductor(s) that had reportedly been damaged by being chewed by a dog. Also to determine the effect of that event on the electrical system(s) including the HVAC circuit(s).

- Additional instructions were received to provide a written Engineering Report.

(D) BACKGROUND:

While it is not the scope or intent of this report to discuss the incident, some basic background information that was provided to EFX is important for the analysis:

- About 28 large dogs had been placed into a room at the southwest corner of the home with the doors closed.

- About 20 dogs were found deceased in the room on June 19, 2014.

- The business/home owner had reportedly claimed that a dog had chewed through one of the circuits in the room causing the HVAC (Heating, Ventilation, and Air Conditioning) system that served that room to fail.

(E) SCENE EXAMINATIONS:

An Electrical Engineering examination of the scene was conducted on July 9, 2014. Present were George J. Hogge PE, Principal Electrical Engineer of Engineering Forensics Experts LLC and Ron Ballard, HVAC Technical Consultant of Getty Engineering Services.

A number of photographs were taken in digital format during the scene examination. Select photographs are attached in this report, some of which have been cropped or rotated to fit. All photographs are stored by EFX in their original format.

The subject structure was a one story single family home of wood frame construction supported by a concrete slab on grade. The sloped roof was supported by typical wood trusses and finished with asphalt shingles. Figure 1 shows a rear view of the home looking northeast and Figure 2 shows a basic Plan View with dimensions. The rooms are shown in the area of interest on the west end of the home.

Figure 1. Rear view of house looking northeast.

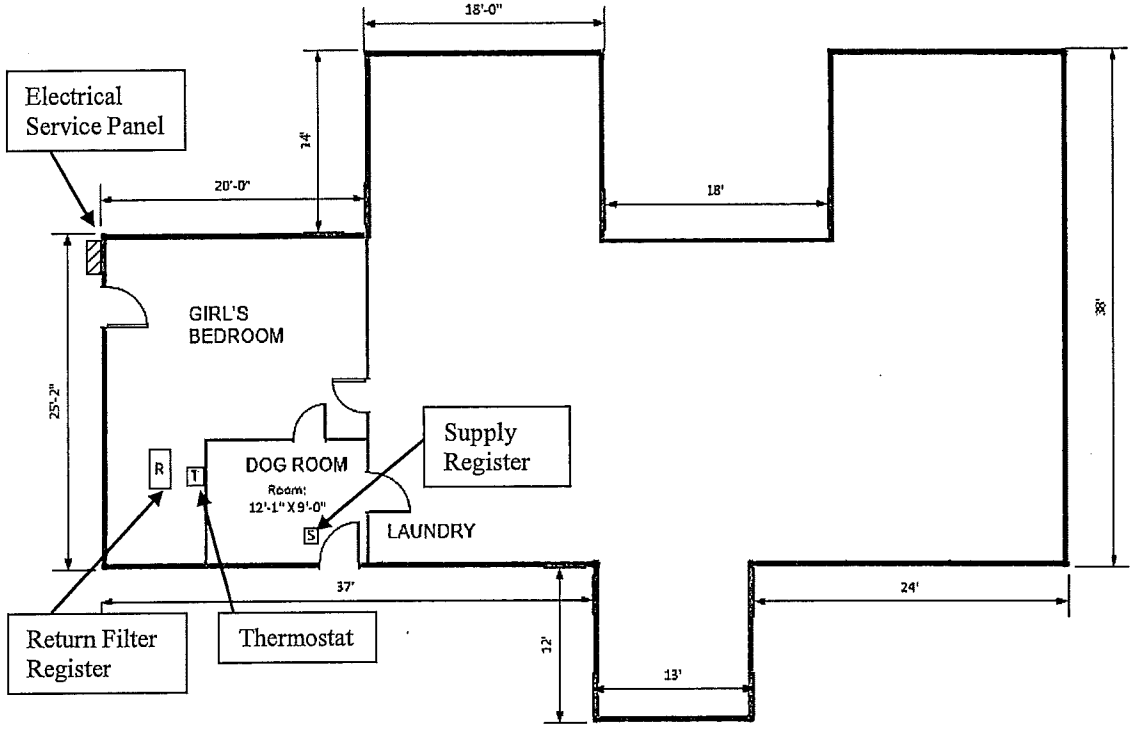


Figure 2. Plan view of house with dimensions for exterior and interior areas of interest. Not to scale.

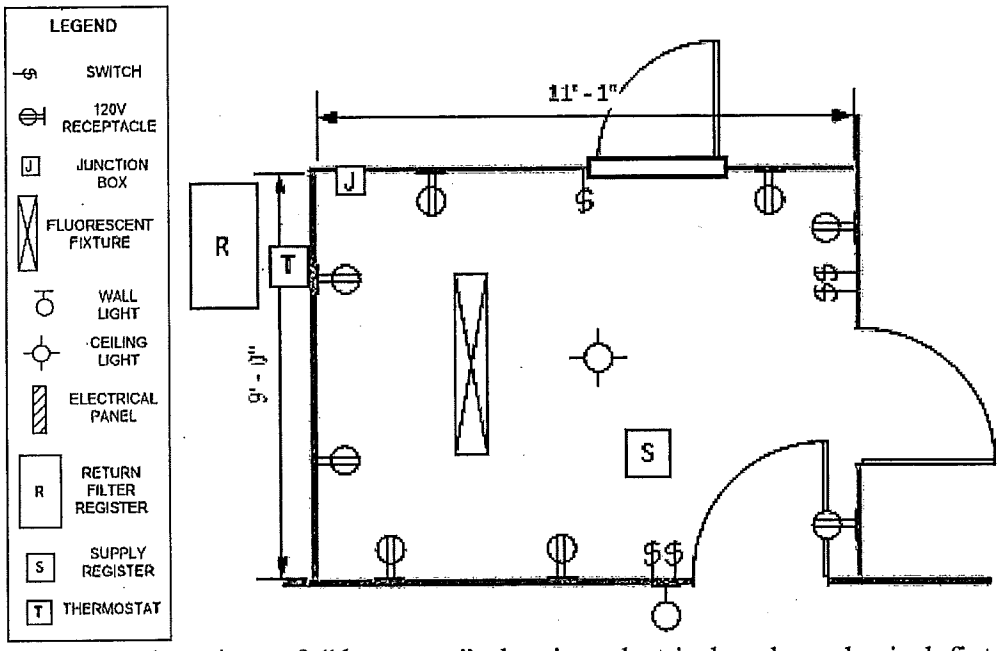


Figure 3. Plan view of "dog room" showing electrical and mechanical fixtures and devices. Not to scale. Red rectangle indicates sealed doorway into girl's bedroom.

Figure 3 shows an enlarged Plan View of the room where the dogs had been placed with the electrical and mechanical components of interest shown. For the purposes of this report, we will refer to this as the "dog room". The door to the north that led into the girl's bedroom had been completely and permanently sealed with caulking such that no air could pass, which is shown by a red rectangle in Figure 3. Note that there is one HVAC (Heating, Ventilation, and Air Conditioning) supply register in the ceiling in the dog room and that the return register and filter as well as the thermostat are in the closet of the girl's room to the west.

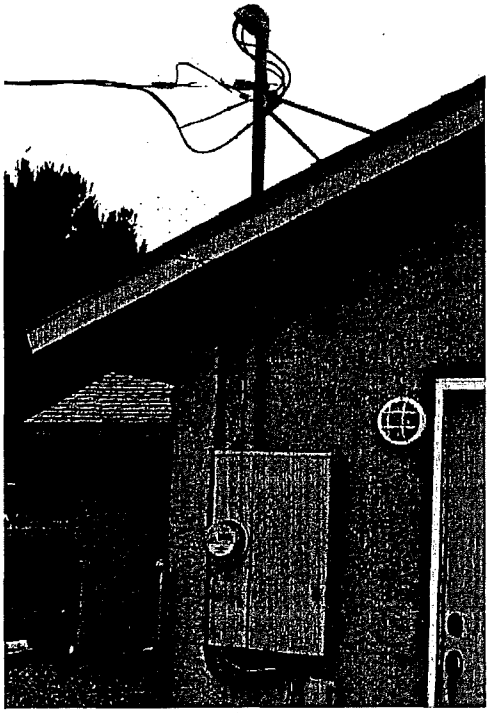


Figure 4. Electrical service.

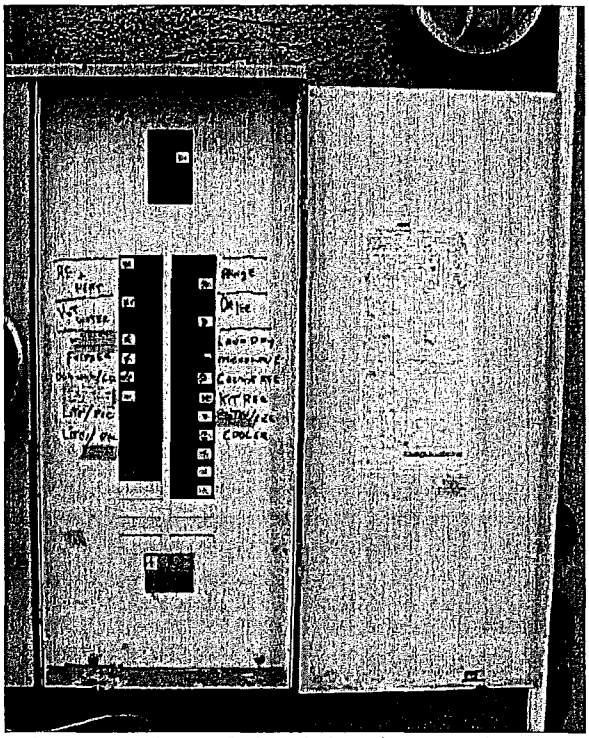


Figure 5. View of circuit breaker panel.

Figures 4-6 show the electrical service panel on the north end of the west exterior wall. The electrical service panel was a typical modern combination metering and circuit breaker panel rated at 240/120 volts, 200 amps, with a 200 amp main circuit breaker. The main service panel was supplied via an SRP overhead lateral from a pole mounted transformer. There was nothing remarkable about the physical condition of the service panel. The panel contained a number of branch circuit breakers that are there to control and protect the branch circuits that extend into the house wiring systems. Apparently some circuits and breakers had been moved as the labeling was not complete nor correct. Otherwise, no remarkable deficiencies in code or workmanship were found.

The electrical wiring within the home was installed using copper Type NM Non Metallic Sheathed Cables, which are intended for and suitable for such use in a residential structure. For purposes of this report, the Type NM cables will be referred to by the trade jargon of "romex". A typical romex cable will have an outer thermoplastic sheath surrounding a specific number of insulated "current carrying" conductors as well as one (1) non-insulated conductor that is intended to be used as a ground conductor only. The number of insulated conductors is typically stated in the sizing convention, for example 14/2 romex will have two (2) insulated #14 AWG conductors and a non-insulated ground conductor. The first run of romex that extends from the circuit breaker at the panel into the structure is typically referred to as the "home run" until it reaches the first device or load.

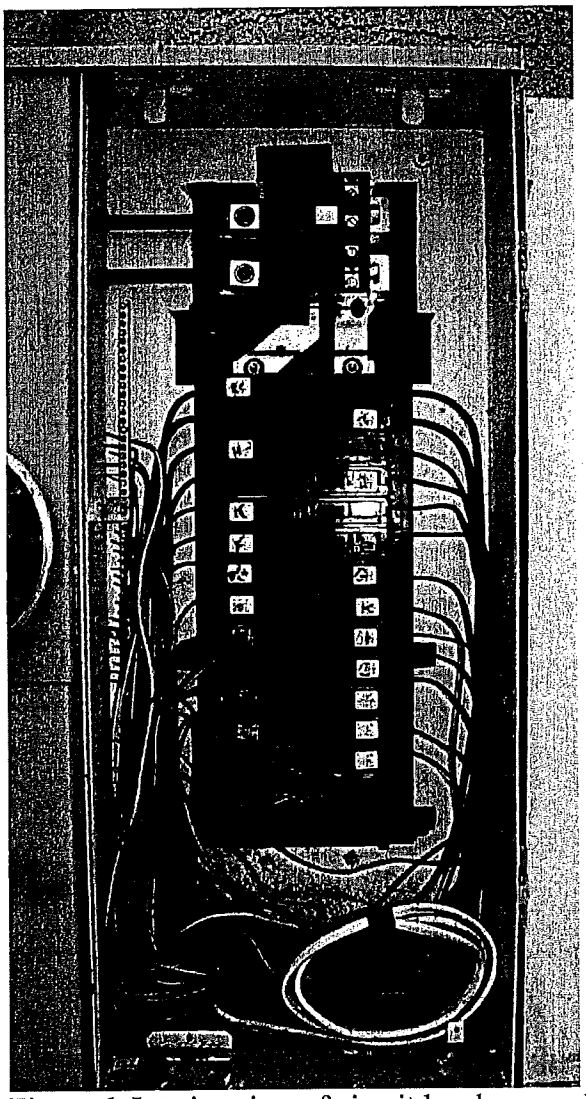


Figure 6. Interior view of circuit breaker panel showing home runs terminated to branch circuit breakers.

Figure 7 shows the south exterior door entering into the dog room and also shows the HVAC system that serves the west portion of the home. For purposes of this report, we will refer to this as the "west HVAC" unit. Figures 8-11 show the interior walls of the dog room, which was measured to be 9 feet by 12 feet and the ceiling was 8 feet, 3 inches from finish floor. The passage door shown in Figure 9 that led to the girl's bedroom had been sealed completely with caulk so no air could pass through at all. The passage door into the laundry room and the exit door to the south yard shown in Figure 10 both had sweeps and weather stripping such that the room was actually fairly tightly sealed.

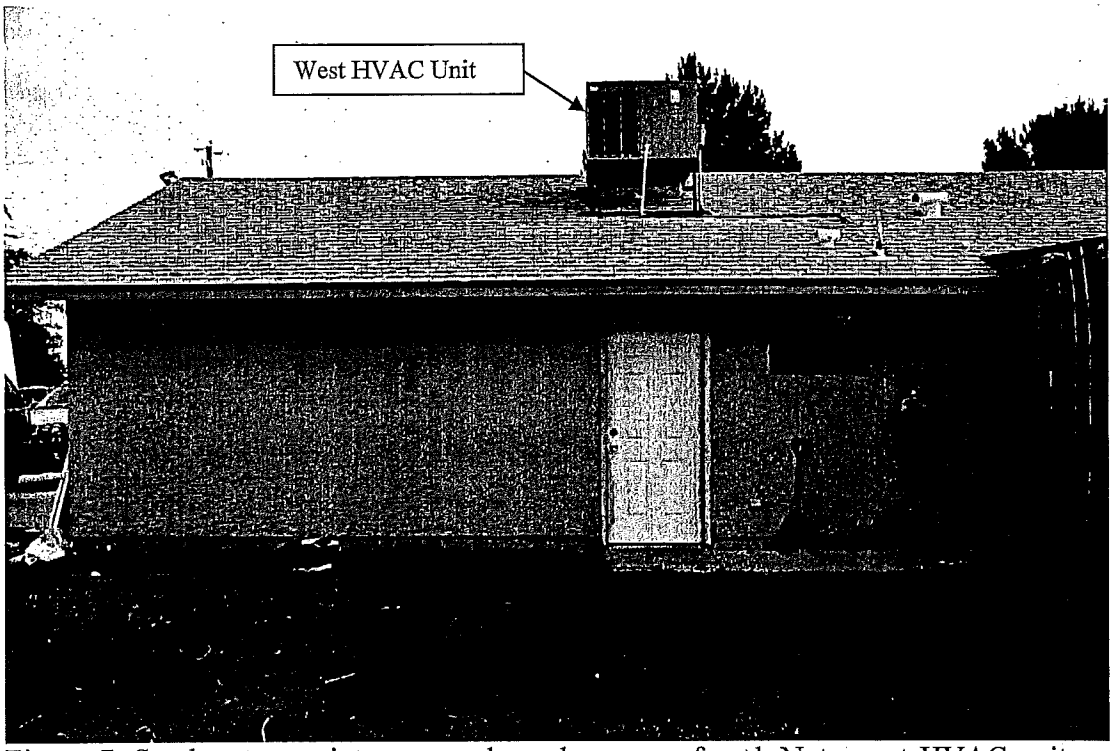


Figure 7. South entrance into room where dogs were found. Note west HVAC unit on roof above door.

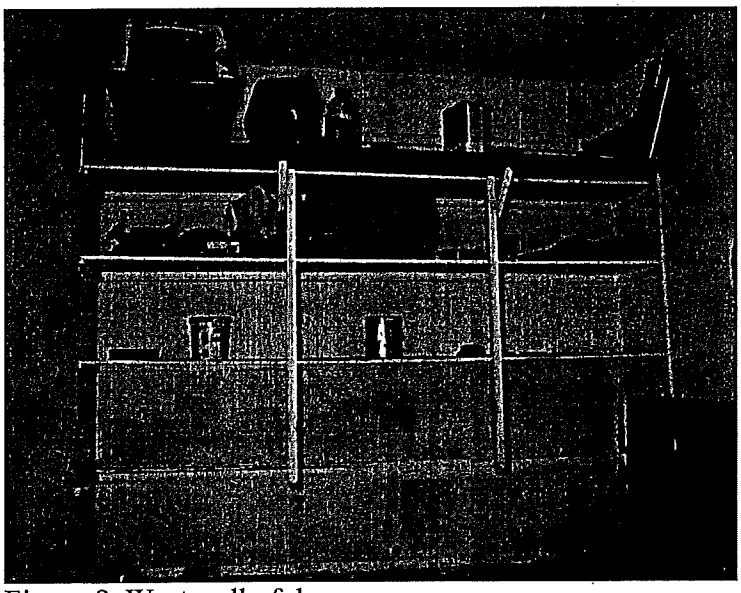


Figure 8. West wall of dog room.

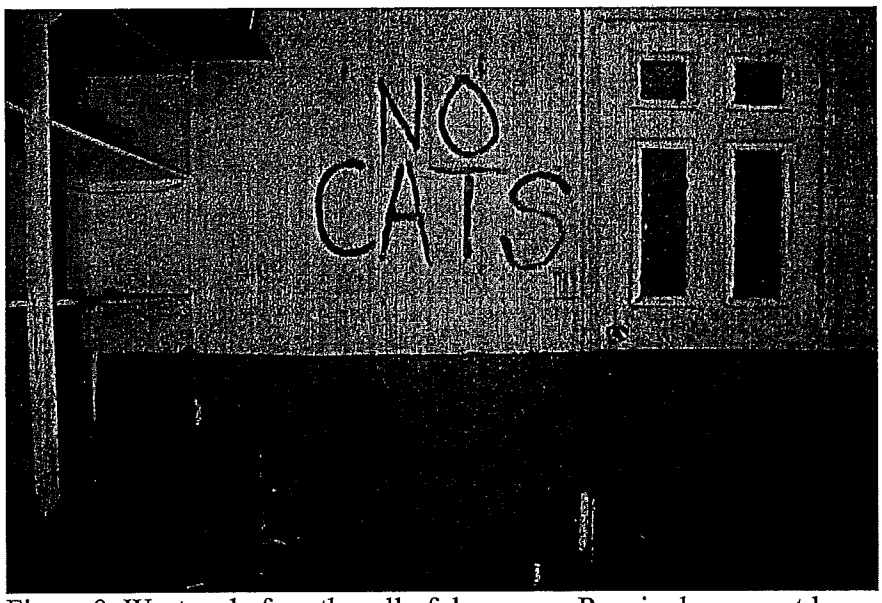


Figure 9. West end of north wall of dog room. Repaired romex at lower left.

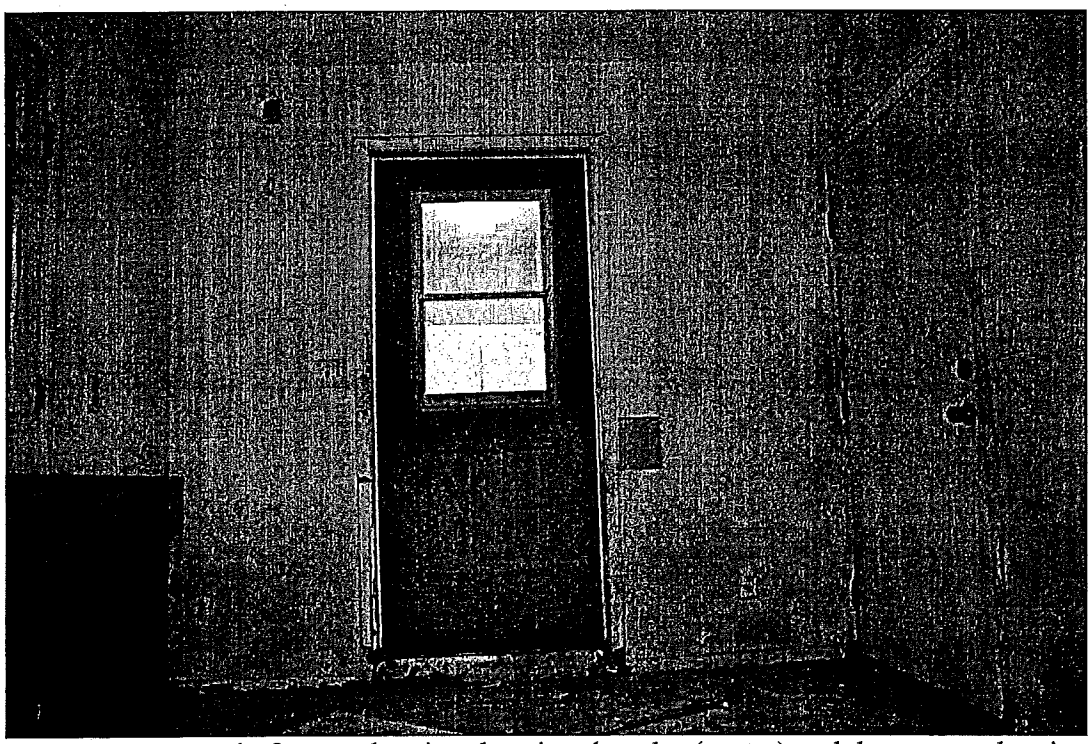


Figure 10. East end of room showing door into laundry (center) and door to south exit on right.

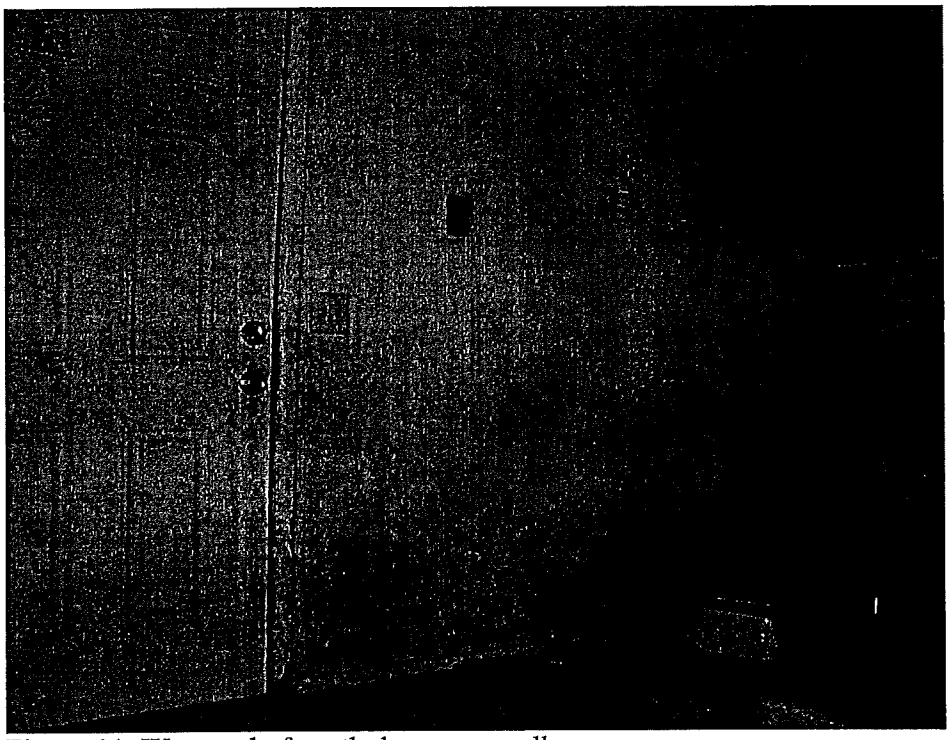


Figure 11. West end of south dog room wall.

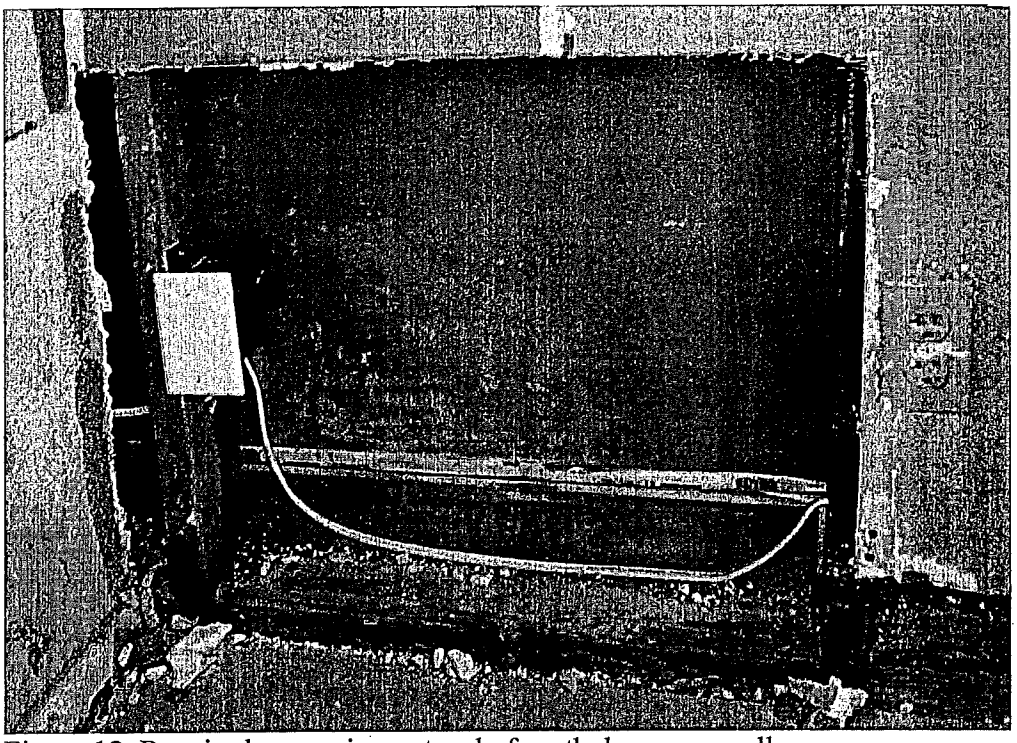


Figure 12. Repaired romex in west end of north dog room wall.

Figure 12 shows the location where the romex cable had reportedly been chewed on by a dog. It was apparent that this segment of cable had been replaced since the incident. A "new" segment of 14/2 romex had been extended from the receptacle in the wall to the east to a plastic junction box that had been installed to make a legal splice in. NEC (National Electrical Code) requires that all splices in any wiring must be accessible from the living space so this junction box was required to make such a splice. As shown in Figure 13, the splice was made using typical "wire nut" splice connectors that are suitable for the purpose.

This circuit was then traced to the source using a toner and it was determined and verified that the circuit was serviced via the 15 amp single pole circuit breaker in the #24 position in the panel as shown in Figure 14. This circuit was limited to receptacles and lighting in the southwest corner of the home.

Figure 13. Wire nuts in junction box.

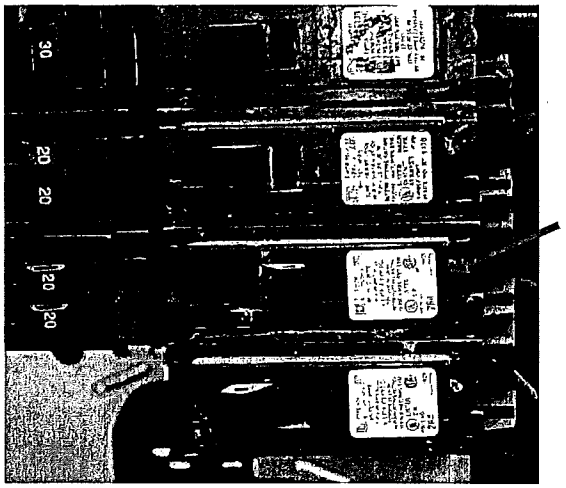


Figure 14. Breaker 24 serves repaired circuit.

Figure 15 shows the remaining end of the original circuit romex at that location, which is a 14/2 cable. It is apparent that the wall was open such that the dog was able to access this cable as evidenced by the blue paint on the external sheathing and the blue paint on the interior backside of the drywall on the opposite side of that wall space. Figure 16 shows that this original segment extended around the corner into the west wall where it was terminated at another duplex receptacle which is a typical residential installation.

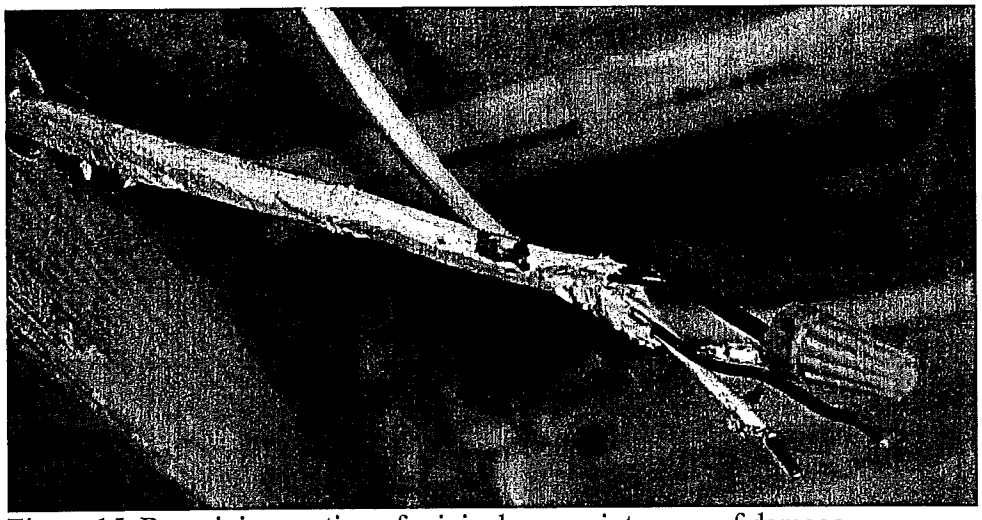


Figure 15. Remaining portion of original romex into area of damage.

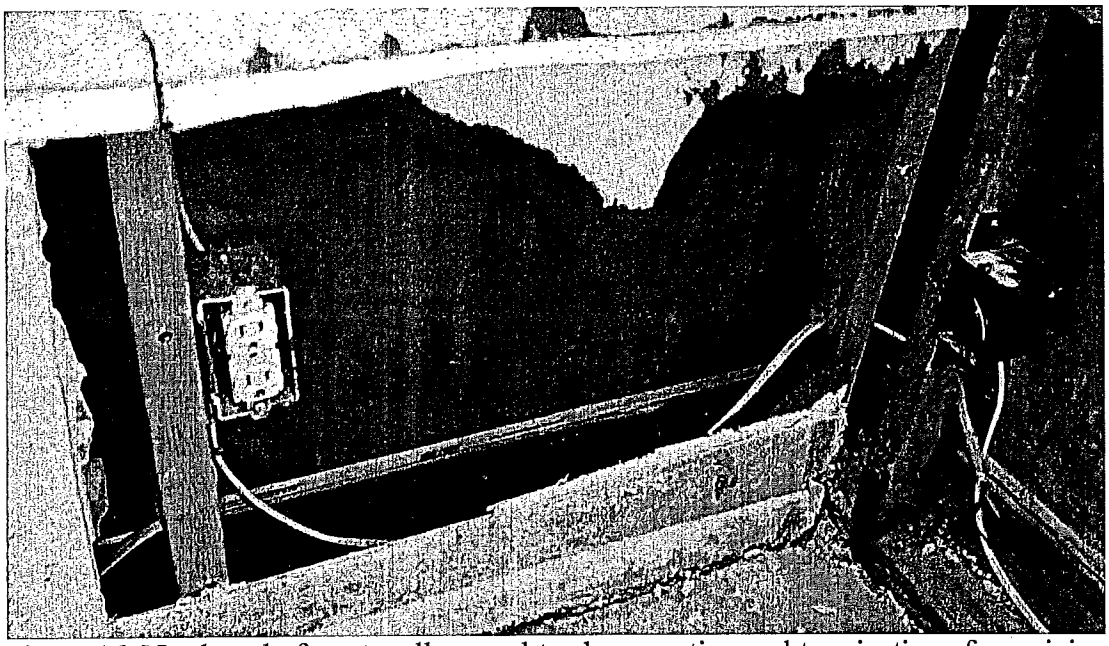


Figure 16. North end of west wall opened to show routing and termination of remaining portion of damaged romex segment.

The testing for a circuit breaker is prescribed by ANSI/NEMA AB4. The typical testing is done to a circuit breaker that has been removed from the system and placed in a specialized test apparatus that can be regulated to flow a prescribed current through the breaker at low voltage. The tripping of the breaker is based on current and not voltage. However, a specialized test based on the ANSI/NEMA protocol was utilized in order to test this system as configured to determine if the HVAC operation could have been affected by a dog chewing on the romex in the wall. The west HVAC was set to run continuously during this testing. The particular tests that were utilized were:

- ANSI/NEMA AB4, Article 5.5: Inverse Time Overcurrent Trip Test: This test is conducted by placing a load of 200 to 300% of the rated current on the breaker and would in this case simulate the current that could be expected if a dog chewed on the cable and caused a short circuit that traveled through the saliva and flesh of the dog's mouth. For this test, a load of about 32 amps was placed on the circuit of the 15 amp breaker as shown in Figure 17. Within less than 20 seconds, the 15 amp circuit breaker tripped (Figure 18) and the current flow ceased. The 200 amp main circuit breaker was unaffected (Figure 19) and the HVAC units continued to operate.

- ANSI/NEMA AB4, Article 5.6: Instantaneous Overcurrent Trip Test. This test is conducted by very quickly ramping the current to multiple times the rating of the breaker and would simulate the dog chewing the cable such that the energized conductor insulation was compromised and it came into direct contact with the neutral or ground, resulting in a direct fault (short circuit). For this test a heavy duty switch was connected to the hot and neutral conductors, then the circuit was energized and the switch was closed (turned on). The 15 am circuit breaker tripped instantaneously, while the 200 amp main breaker was unaffected. The HVAC units continued to operate.

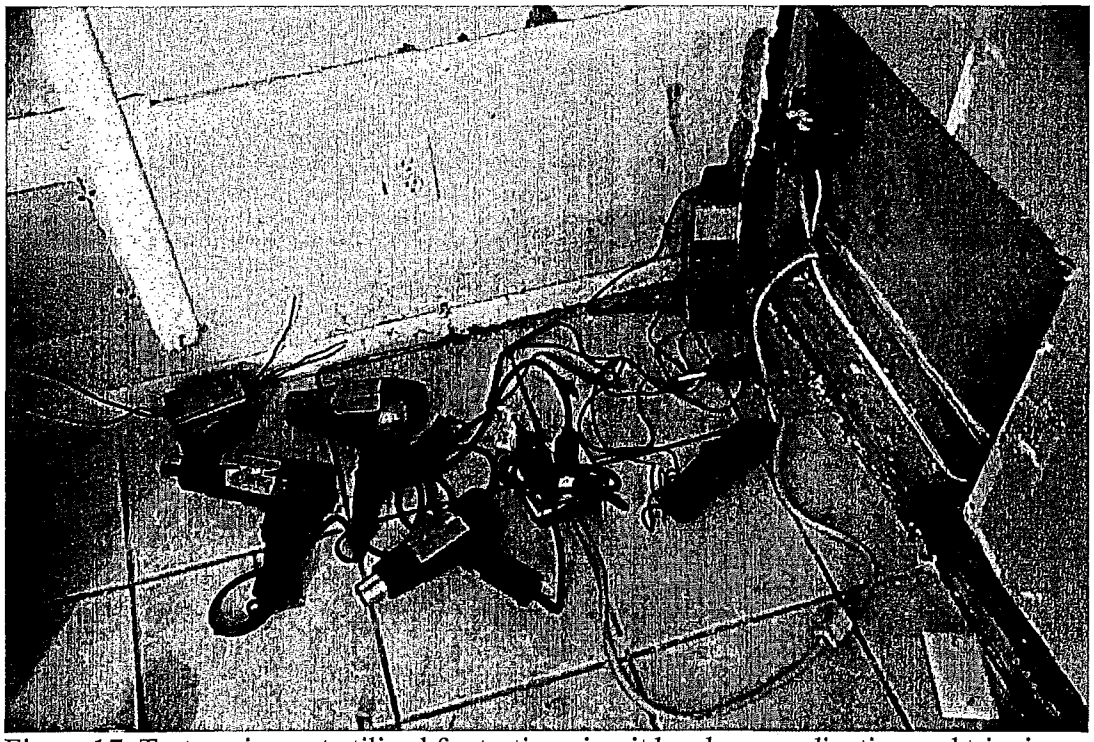


Figure 17. Test equipment utilized for testing circuit breaker coordination and tripping.

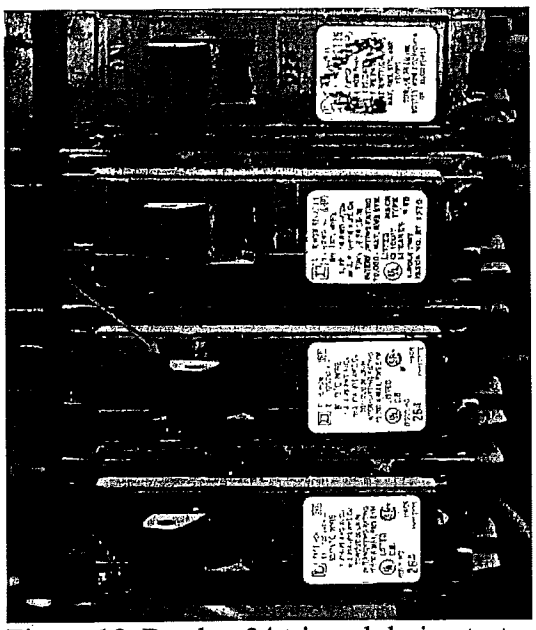


Figure 18. Breaker 24 tripped during tests.

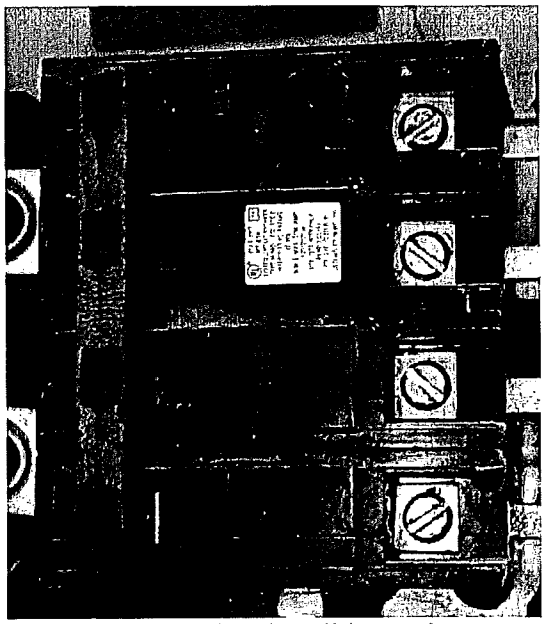


Figure 19. Main breaker did not trip.

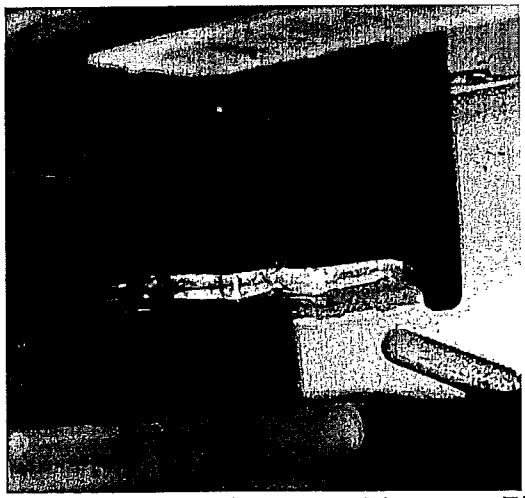


Figure 20. Bus stab at space 24.

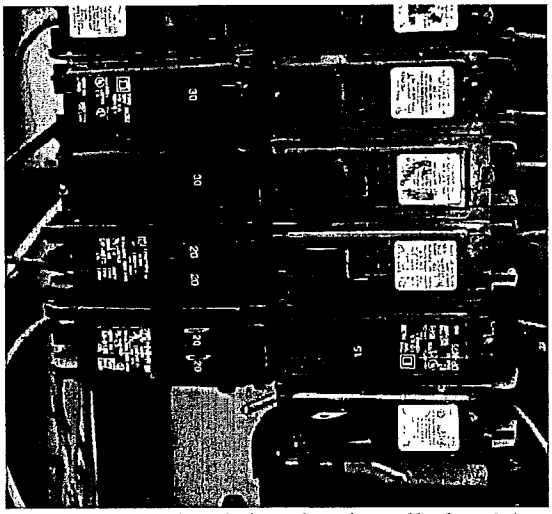
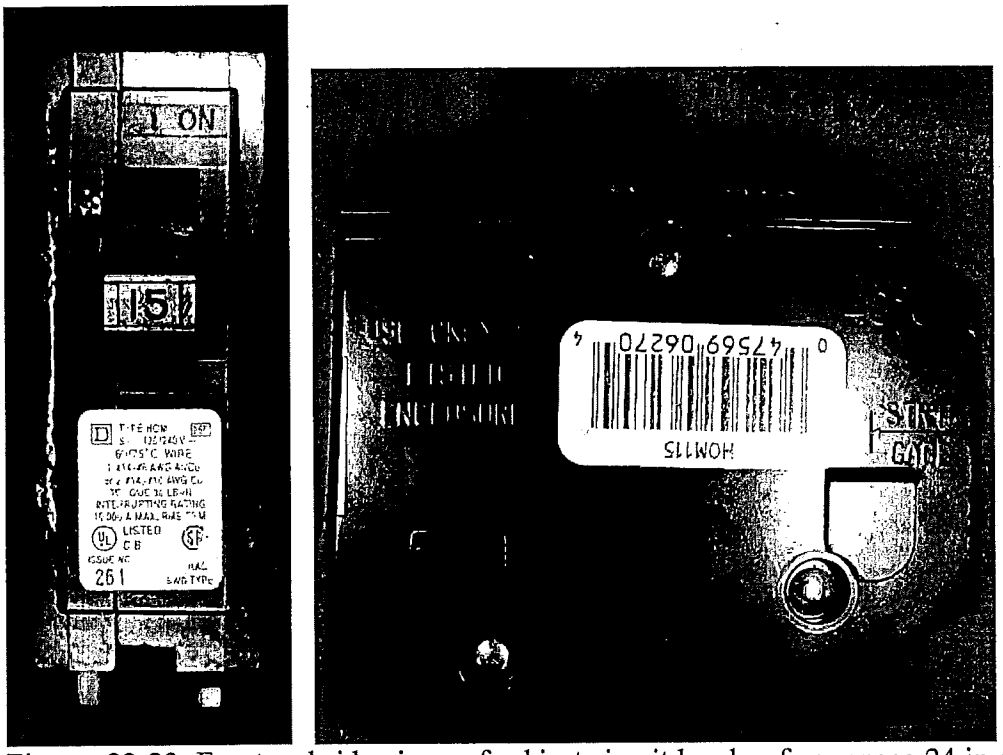


Figure 21. New circuit breaker installed at 24.

The 15 amp circuit breaker was then removed from space 24 and retained as evidence. Figure 20 shows the bus stab where the circuit breaker had been installed into the panel and the factory grease is still present, indicative of no heating or other anomaly of the circuit breaker. A new 15 amp single pole breaker was installed and terminated to the circuit as shown in Figure 21 so power could be restored to the circuit.

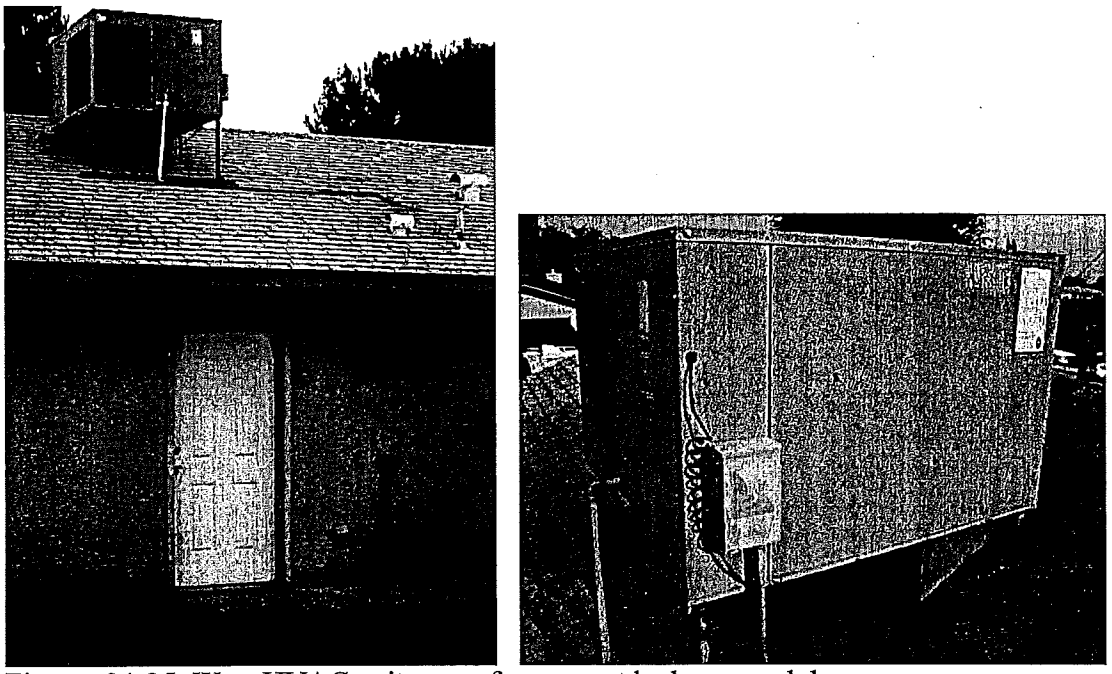
The 15 amp single pole circuit breaker from space 24 was then examined and there was nothing remarkable about the circuit breaker (Figures 22-23).



Figures 22-23. Front and side views of subject circuit breaker from space 24 in electrical service panel.

HVAC Examination and Testing:

HVAC Technical Consultant Ron Ballard inspected the HVAC system that served the west side of the house including the girl's bedroom with closet and the separate room where the dogs were kept, the "dog room". Figures 24-25 show the location of the package HVAC unit on the house.



Figures 24-25. West HVAC unit on roof over west bedroom and dog room.

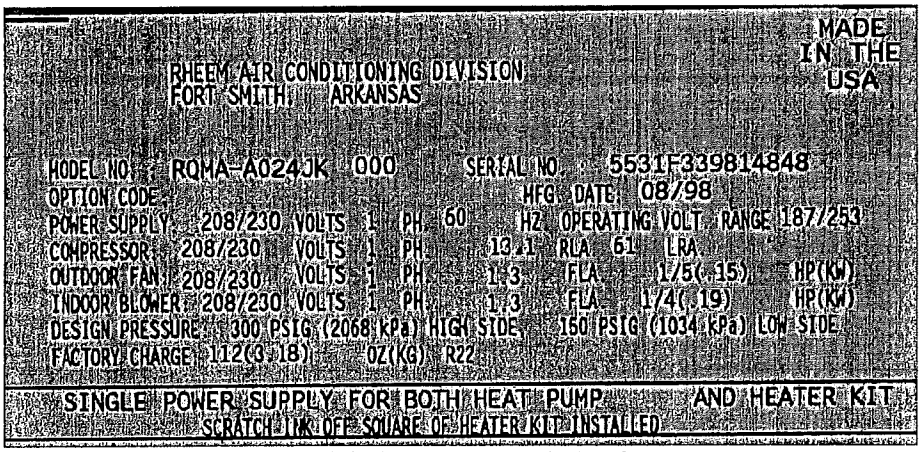


Figure 26. Manufacturing label on west HVAC unit.

Figures 25-26 were taken on the roof. The west HVAC unit is a 2 ton Rheem HP model #RQMA-A024JK, serial #5531F339814848. Unit was built in the 33rd week (approximately August) of 1998. Fuses in unit disconnect were rated for 30 amps and the

breaker in panel was also a 30 amp, 2 pole. The west HVAC unit was tested through the typical cooling cycles and operated normally, producing cool air.

The duct work associated with the west HVAC unit was surveyed in the attic. The unit had two 8" supply runs to the daughter's room and one 7" supply run to the dog room. The return was a single 14" run with a 16x25 inch filter in the daughter's bedroom. There was no return or passage from the dog room for air to exit.

The thermostat and the only return air register for the west HVAC were found in the closet of the girl's bedroom as shown in the Plan View of Figures 2 and 3 and in the Photos of Figures 27-28. Figure 28 shows filter in filter grill. It is extremely bowed up because air is not flowing easily through air filter. Figure 29 shows the return air filter on the ground and the filter was found to be extremely dirty.

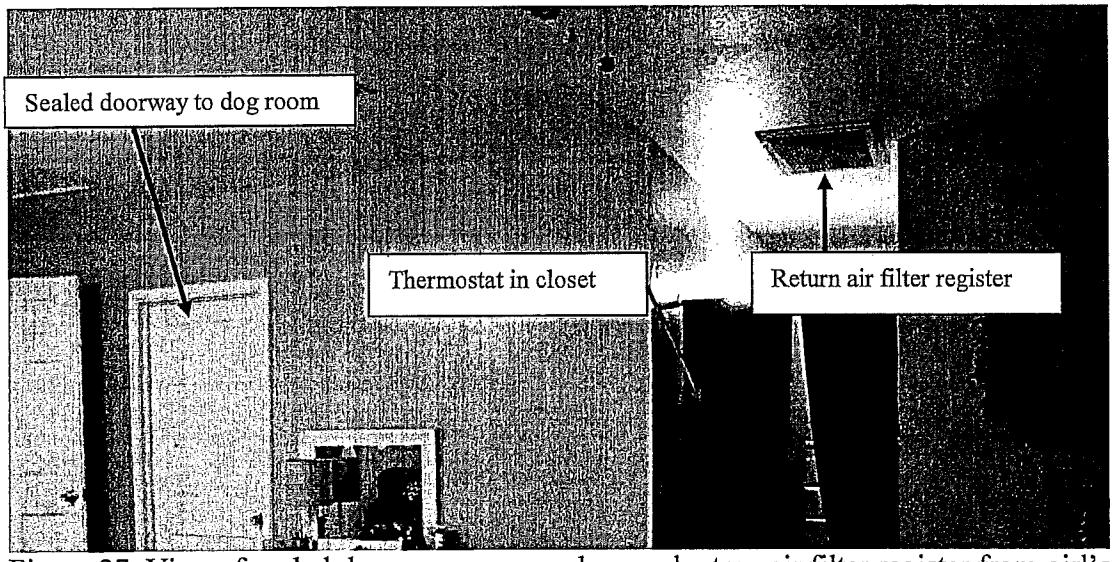
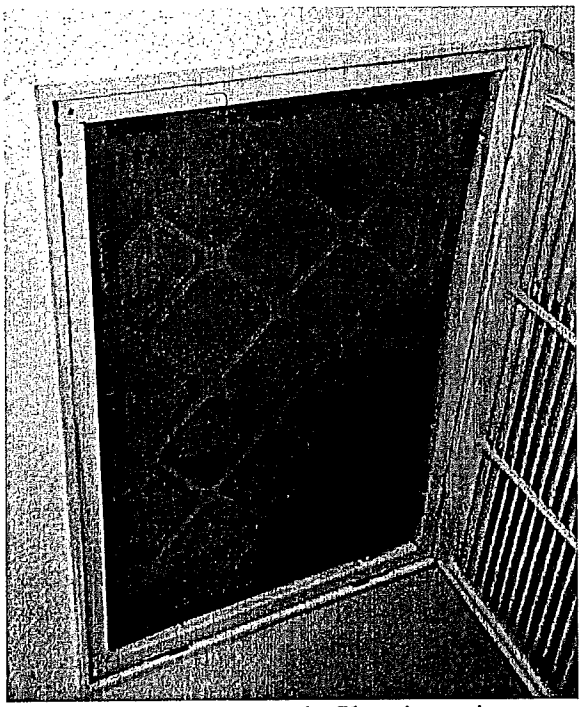
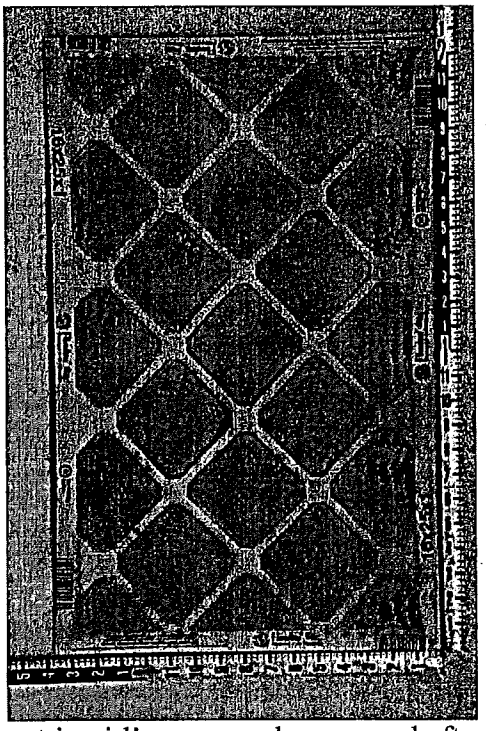


Figure 27. View of sealed dog room passage door and return air filter register from girl's room looking south.

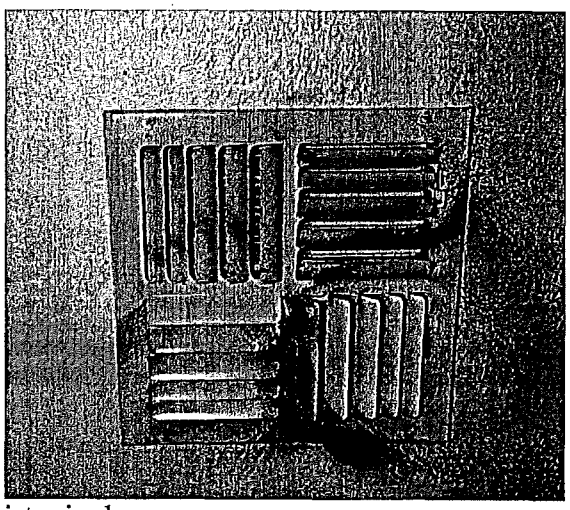




Figures 28-29. Return air filter in register over closet in girl's room and on ground after removal.

At 7:45 am, Mr. Ballard was asked to take a temperature reading in the room where 2 dogs were being held. Temperature was measured at 79.5°F but at the time of the temperature reading, the dogs had been removed and the doors that lead to the laundry area and outside were open.

At this time, Mr. Ballard began setting up equipment to take air flow readings in the room that housed the dogs. The equipment utilized was a Fieldpiece HS36 multimeter with a Model AAV3 flow measurement attachment. There was no return register and only one 10"x10" ceiling mounted supply register in the room. Louvers faced 4 directions on the supply register as shown in Figures 27-28.

Figures 27-28. Single 10" by 10" supply register in dog room.

Two readings were taken from each quadrant of the register with the doors open, and that test was repeated with the doors closed. The readings were then averaged. As mentioned above, the doors created a fairly tight seal on the room when closed. It was remarkably difficult to open the exterior door (which opens inward) when the HVAC unit was blowing air into the room due to the tight seal of the room envelope.

Following is a chart with doors open:

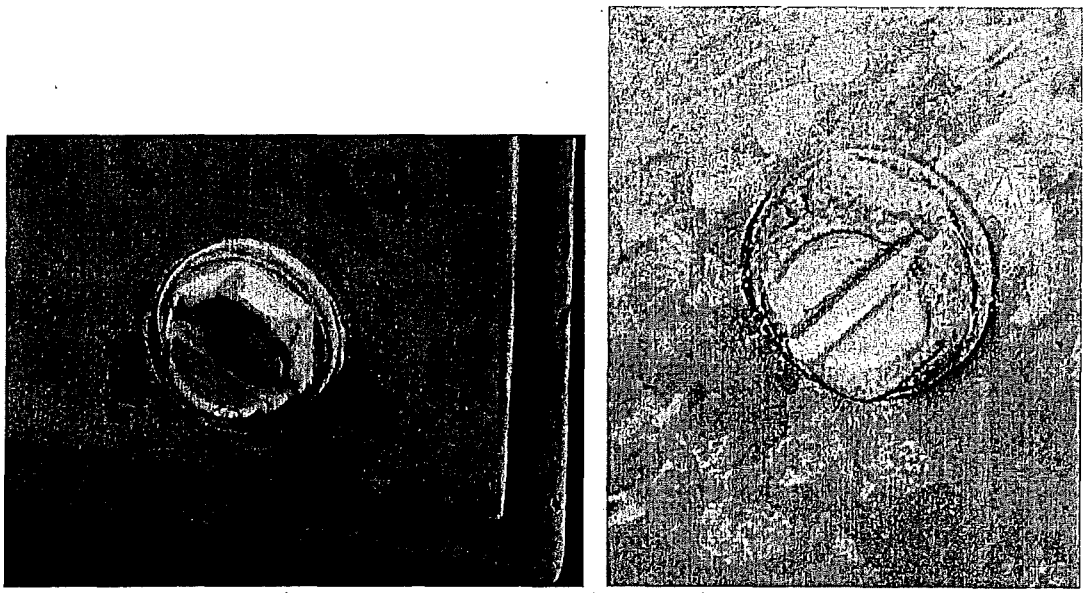
Register	Airflow Readings			
Quadrant	1	2	Total	Average
SE	545	545	1090	545
SW	465	485	950	475
NW	245	300	545	273
NE	165	299	464	232
			Average CFM Total	1525
			Average CFM	381
			Factor for register size (.83x.83)	0.689
			Calculated CFM	263

Following chart with doors closed:

Register	Airflow Readings			
Quadrant	1	2	Total	Average
SE	372	230	602	301
SW	252	200	452	226
NW	137	122	259	130
NE	29	42	71	36
			Average CFM Total	692
			Average CFM	173
			Factor for register size (.83x.83)	0.689
			Calculated CFM	119

As the charts show, there is a significant reduction of air flow into this room when the doors are closed. The CFM's (Cubic Feet per Minute) dropped from 262 CFM with doors open to 119 CFM with doors closed.

A closer inspection of the west HVAC unit on the roof found that the screws holding the panel for the controls showed no signs of having been opened for some time (Figures 29-30). The screws that held the panel cover inside unit had not been opened. One interior cover screw had 1/8 inch of dust on it. Figure 31 shows that there is a significant amount of dust on the interior wiring and components as well. This would indicate that no-one had serviced this unit in quite some time.



Figures 29-30. Mounting screws on west HVAC exterior and interior panel covers for accessing service bay area.

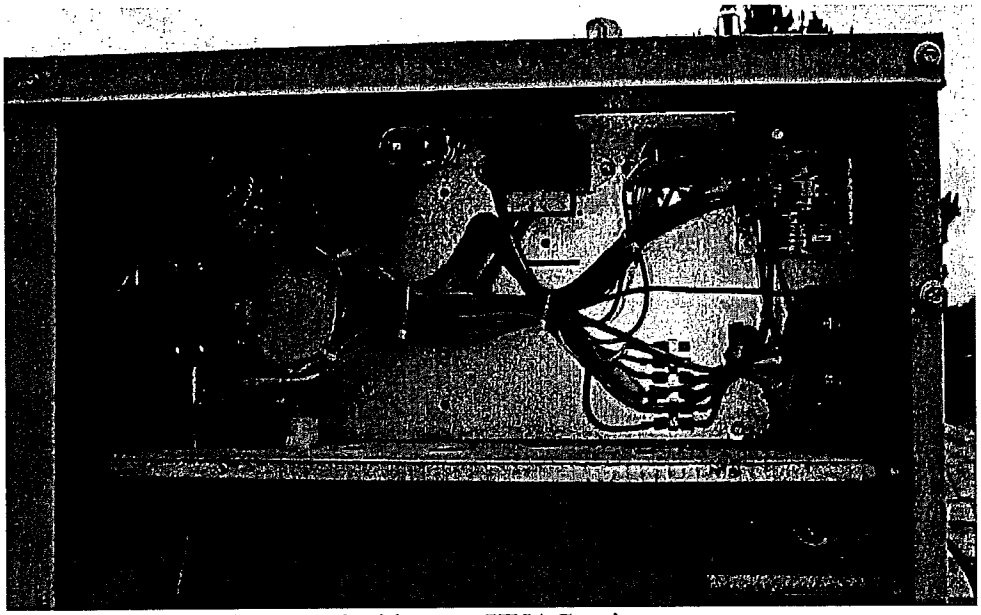


Figure 31 Service bay area inside west HVAC unit.

(F) ANALYSIS:

The electrical systems of the home were found to be in serviceable condition with no anomalies. The segment of romex cable that had reportedly been chewed through by a dog had been removed and replaced, therefore could not be analyzed, however the testing conducted by EFX was effective in determining the possibility of whether if a dog did chew through that cable and cause any faulting (short circuit), if that could cause any failure of the HVAC system.

The circuit breaker that served and protected the lighting and receptacle circuit which included this segment was a typical 15 amp single pole circuit breaker installed in the typical fashion within the main service panel. The circuit breaker that served and protected the west HVAC unit was a typical 2-pole 30 amp circuit breaker also installed within the service panel. As such, these circuit breakers are in parallel and the only possible way that a fault on the receptacle circuit could affect the HVAC is for it to have tripped the 200 amp main circuit breaker, which would have turned off the power to the entire house. This of course would have resulted in spoiling of food in the refrigerator, freezer, etc., as these circuit breakers do not reset themselves. The only scenario where the 200 amp breaker could possibly trip due to a downstream fault in the circuit would be if the 15 amp circuit breaker failed to clear that fault for a significant amount of time.

The testing conducted by EFX utilized the series system of the 15 amp receptacle circuit breaker with the 200 amp main breaker to comprehensively test for the unlikely event of tripping the 200 amp main due to any fault at this location in the circuit.

There was no evidence of any failure of the electrical system of the home that could cause or contribute to any failure of the HVAC system. There was no evidence of any electrical or mechanical failure of the HVAC system.

The chart in Figure 32 shows the calculated available fault current at the service panel and at the location of the damaged romex in the northwest corner of the dog room. The available source fault current (Isc) of 10,792 amps at the SRP transformer is from SRP literature and basically says that if you shorted out the wires at the transformer that is all the current you would get there. The impedance or resistance of the conductors as you travel downstream from the source will significantly reduce the amount of current that you can draw with a "bolted fault" or a dead short. The Isc or greatest possible fault current available at the main service panel is 4,641 amps (green highlight) and the Isc at the receptacle is 483 amps (yellow highlight). This tells us that the most current we could possibly get through the electrical system due to a fault at that location where the dog reportedly chewed through the wires would be 483 amps, which is 32 times the 15 amp rating and 2.4 times the 200 amp breaker rating. It is important to note that since the fault was at the romex, 483 amps is the greatest possible current that would flow through the 200 amp main which is in series upstream. The actual short circuit amperage for a dog chewing on the romex was likely much lower but we will use worst case possible for our calculations and analysis.

Locations	Length	Start Isc	Constant	# of cond	voltage	f factor	M	Isc @ end	Conductors used
	L	I	C	n	E				
SRP xfmr to SES	100	10792	5876	1	240	1.32543	0.43	4641	3-1/0 Aluminum
SES to damaged romex	50	4641	389	1	120	8.609654	0.104	483	14/2 copper romex

Note: Isc of 10792 amps for SRP xfmr secondaries from SRP Electric Service Specifications pg 1-31, Table 1.

Note: calculations and Constant factors per formulas and tables given in

Cooper Bussmann SHORT CIRCUIT CURRENT CALCULATIONS

Figure 32. Calculations for short circuit current available at service panel and subject romex segment.

Appendix 1 below shows the time-current curves for a 15 amp Square D circuit breaker. The red lines show the results of EFX testing at 200% of the rated current and we see that the circuit breaker tripping at less than 20 seconds is within the manufacturer's specified results (shaded area on chart). The green lines on the chart show that this breaker will trip within $1/60^{th}$ of a second at 32 times the current or a direct short. This was shown to be functional on the 15 amp breaker, as there was not time to even start the stop watch timer before the breaker tripped for the short circuit test.

Appendix 2 below shows the time-current curves for a 200 amp Square D main circuit breaker. The red lines show the maximum Isc of 2.4 times the rating and it would take from 30 to over 300 seconds for that current to trip the main. From practical experience and "real world" observations of this Journeyman Electrician of 35 years, this does not happen, and would have melted the 14/2 romex, which didn't happen. Clearly, it is impossible that this 200 amp main tripped, therefore it is clearly impossible that any dog chewing on the 14/2 in that wall caused any failure of the HVAC system.

West HVAC System Analysis:

Adtek Accuload software was utilized to conduct minimum A/C load calculations and CFM's for the room. Appendix 3 below shows the results of those calculations with 28 dogs in the room (job #1005-1). Appendix 4 below shows the results of those calculations with 20 dogs in the room (job #1005-2).

Page 1 on the line that shows "room internal loads" has sensible and latent BTU gains. Page 2 on the line "dog room" shows summer calculated CFMs. At the bottom of each load calculation it shows the total cooling load in BTUs.

Essentially, the results demonstrate that with good airflow and a clean filter, the 2 ton unit is not adequate to cool the space. Obviously, with a totally plugged air filter and no return from the sealed room, that already inadequate condition is exacerbated significantly. It is very important to realize that in the configuration of this west HVAC system, there are 3 supply ducts from the same manifold, so if you block the airflow to one of those (by closing doors in a sealed room), the already inadequate airflow will be

diverted to the other 2 ducts. The other 2 supplies are also in the room with the return so that is the more natural flow.

A plugged return filter will cause a number of problems with an HVAC unit besides poor airflow and poor cooling, including the likely condition of freezing up the indoor coil (evaporator coil) which will block all the airflow and render the unit completely ineffective.

It is also important to consider the fact that the thermostat that controls the west HVAC was in the closet below the return air filter register. With the airflow blocked to the dog room, the unit would cool the space within the girl's room and satisfy the thermostat while having negligible cooling effect on the dog room.

Some very practical issues are that the heat given off by the dogs would result in significant heat gain within the room and with no airflow, 28 dogs would use the available oxygen rapidly. The room volume was less than 900 cubic feet of air. These animals also pant to cool themselves so they will significantly raise the humidity, making it much more likely that the indoor coil will freeze up even with adequate ventilation due to the plugged filter.

Even if the west HVAC unit did not freeze up, clearly there would not be sufficient airflow to cool the animals and likely not enough turnover of the air to replenish the oxygen as needed.

Recommendations:

The first remedy to the problem could be to have two 8" supply ducts to the dog room or one 10" run. You would need an air return in this room or an exhaust fan. A 2 ton unit cannot handle the heat load or CFMs for these two rooms. It would need to have at least a 2 ½ ton unit. The thermostat should be in the dog room as this has the greatest heat load. The second remedy would be to install a 1 ton ductless unit in the dog room and you would still need to have an exhaust fan in the room to replenish the oxygen. No matter which remedy is used it is imperative to keep the air filters clean.

(G) CONCLUSION:

The reported damage to the circuit caused by the dog chewing on the romex could not have possibly caused any interruption of the west HVAC system operation.

The west HVAC system was wholly inadequate for this type of utilization of the "dog room". This inadequate condition was exacerbated by the airflow limitations with the room and fact that the HVAC system was neglected as to maintenance including the basic requirement of changing the filter.

These conclusions were reached with reasonable scientific certainty based on:

1. Forensic Examinations of the scene and evidence at the scene.
2. Testing of the electrical system at the scene.
3. Testing of the HVAC system at the scene.
4. The undersigned investigator's education, training, and experience as a Journeyman Electrician and Registered Professional Electrical Engineer.

(H) COMMENTS:

The statements and conclusions contained herein are based on the information given to and gathered by Engineering Forensics Experts at the time of this report. If additional information becomes available we reserve the right to change our conclusions.

The evidence listed below will be held in secure storage at Engineering Forensics Experts LLC.

Thank you for the opportunity to be of service.

George J Hogge P.E. 7/12/14

SIGNATURE DATE

George J. Hogge PE
Principle Forensic Engineer

(I) EVIDENCE CUSTODY & CONTROL

EFX **ENGINEERING FORENSICS EXPERTS LLC**

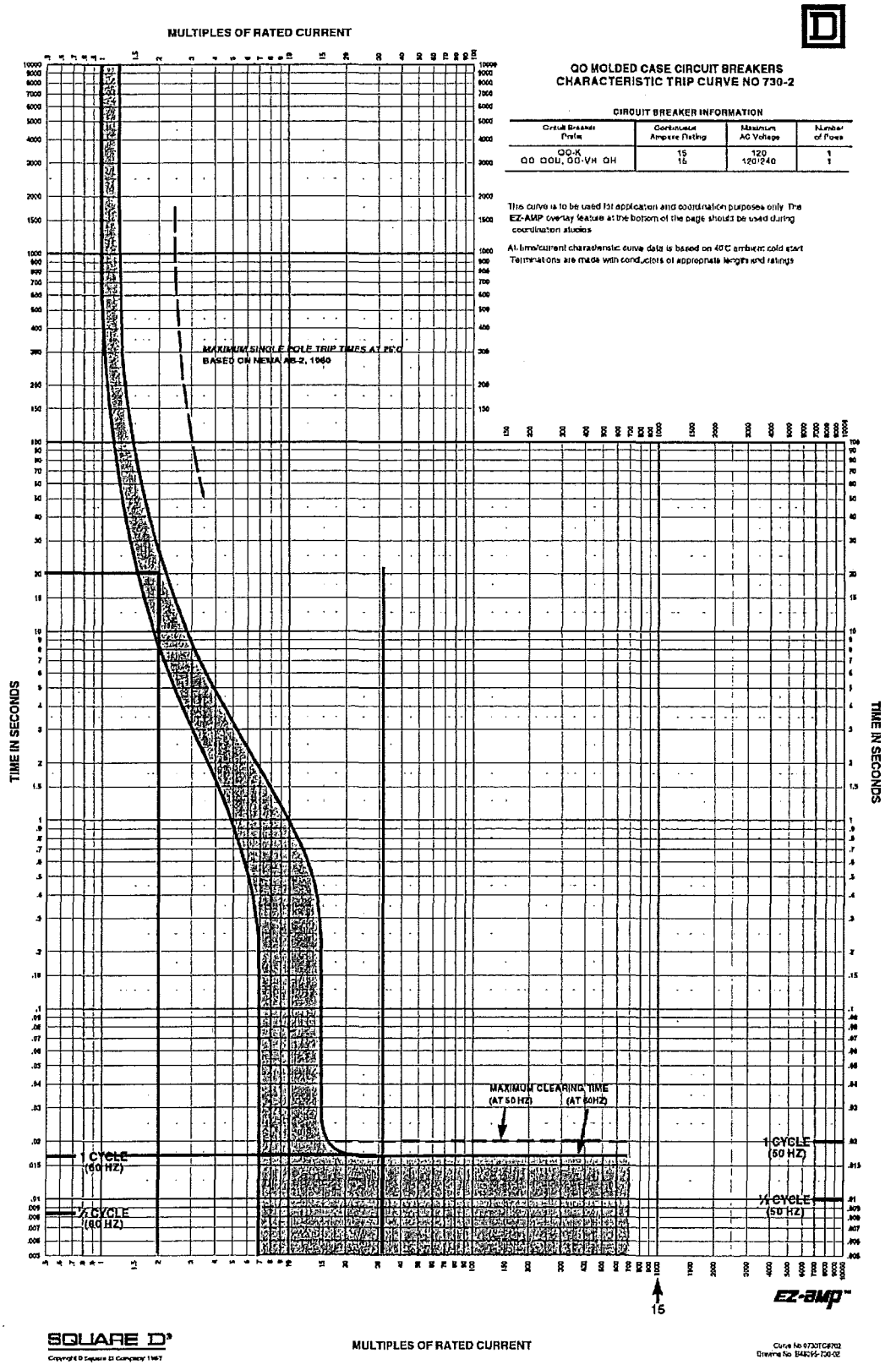
EFX File No: 4874-0701
Maricopa County Sheriff's Office
Attn: Lt. David Toporek

Date of Incident: June 19, 2014
Location of Incident: 15723 E. Appleby Road, Gilbert, AZ 85298
Date Evidence removed: July 9, 2014

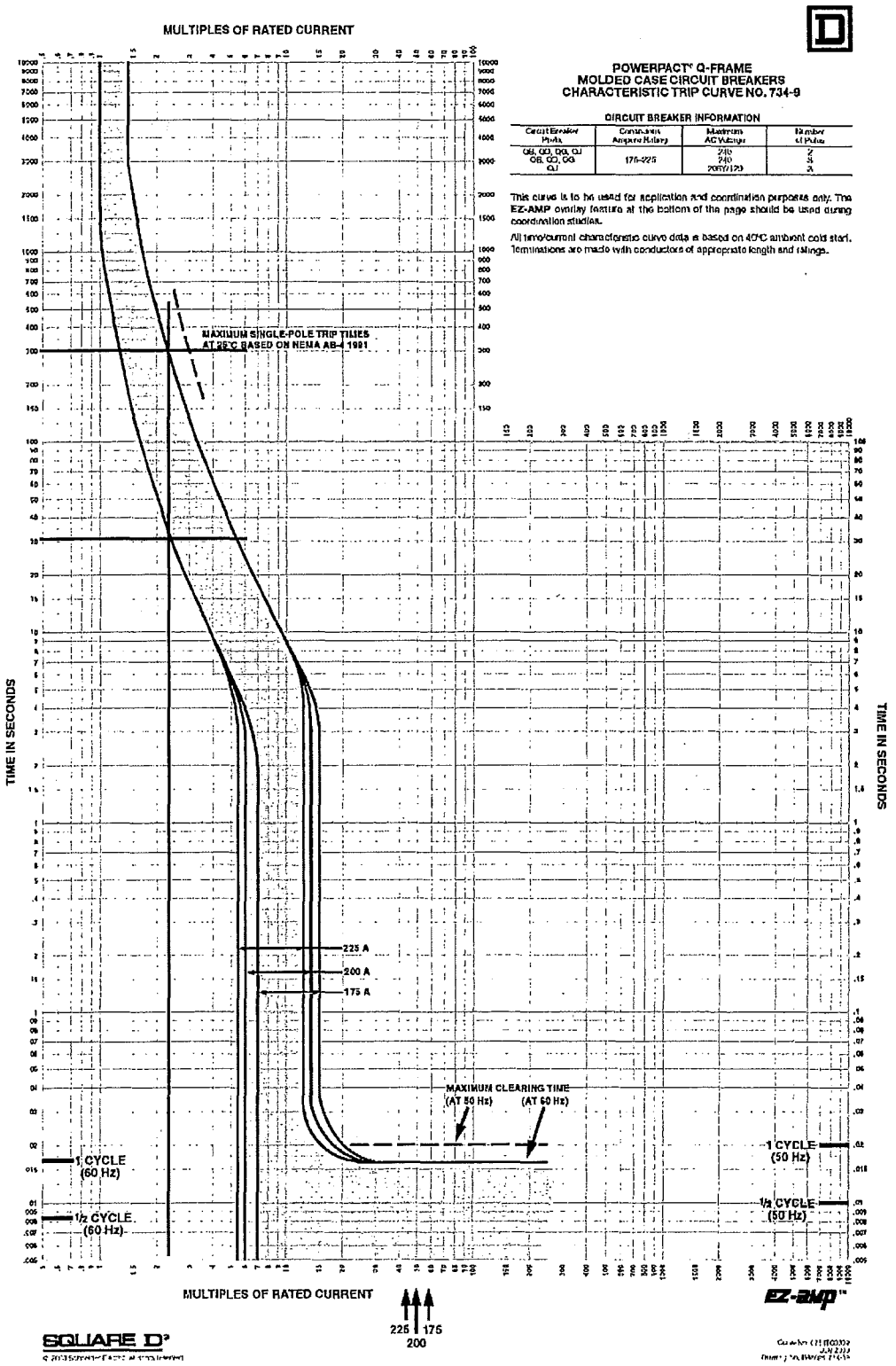
#	Description	Location From
1	15 amp single pole circuit breaker	Service panel on west end of home, space 24

Note:
Numerous other evidence artifacts were collected and retained by MCSO and are not listed in this report.

APPENDIX 1. TRIP CURVES FOR 15 AMP SQ D CIRCUIT BREAKER



APPENDIX 2. TRIP CURVES FOR 200 AMP SQ D CIRCUIT BREAKER



APPENDIX 3. HVAC CALCULATIONS WITH 28 DOGS IN ROOM

Ron Ballard
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602-228-7752 - ronnsue2010@hotmail.com

Green Acre Boarding MCSO IR 14-014274
15723 E. Appleby
Gilbert , AZ 85298

Sales Consultant: Ron
Job#: 1005-1
Date: 07/11/2014

System I (Average Load Procedure)

Design Conditions

Location:	Phoenix AP, Arizona		Elevation:	1133 ft	Daily Range: High
Input Data:	Outdoor Dry Bulb	Indoor Dry Bulb	Latitude:	33° N	Design Grains: -8
Summer:	108	75	Heated Area	454 Sq.Ft.	
Winter:	37	70	Cooled Area	454 Sq.Ft.	

Heat/Loss Summary (July Heat Load Calculations)

	Gross Area	Loss	Sensible Gain	Latent Gain
Walls	474.25	863	846	0
Windows	48	2012	2746	0
Doors	42	776	966	0
Ceilings	453.75	734	1225	0
Skylights	0	0	0	0
Floors	62	2024	0	0
Room Internal Loads		0	6440	5040
Blower Load			1707	0
Hot Water Piping Load		0	0	0
Winter Humidification Load		0	0	0
Infiltration		1361	714	-107
Ventilation		0	0	0
Duct Loss/Gain EHLF=0.06 ESGF=0.13		466	1682	0
AED Excursion		n/a	0	n/a
Subtotal		8236	16326	4933

Total Heating	8236	Btuh
Total Cooling	21259	Btuh

Approved ACCA MJ8 Calculations

17 Linear ft. of Hydronic Baseboard

*Calculations are based on the ACCA Manual J 8th Edition and are approved by ACCA. All computed calculations are estimates based on building use, weather data, and inputted values such as R-Values, window types, duct loss, etc. Equipment selection should meet both the latent and sensible gain as well as building heat loss.

Ron Ballard
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602-228-7752 - ronnsue2010@hotmail.com

Sales Consultant: Ron
Job#: 1005-1
Date: 07/11/2014

Green Acre Boarding MCSO IR 14-014274
15723 E. Appleby
Gilbert , AZ 85298

Equipment Selection

Design Conditions

Design Location:	Phoenix AP, Arizona	Relative Humidity:	45%
Elevation:	1133 ft	Summer Outdoor Design:	108
Latitude:	33° N	Winter Outdoor Design:	37
Daily Range:	High	Summer Indoor Design:	75
Design Grains	-8	Winter Indoor Design:	70

Heating Equipment

Mfg:		Altitude Correction Factor:	.04
Model:		Heating Input (btuh):	
AHRI Ref #:		Heating Output (btuh):	
Efficiency (AFUE):		Calculated HeatPump Output @ Design (btuh):	

Cooling Equipment

Mfg:	Rheem	Altitude Correction Factor:	.03
Oudoor Unit Model:	RQMA-A024JK	Rated Total Cooling (btuh):	24000
Coil:		Sensible Cooling (btuh):	18000
Furnace:		Latent Cooling (btuh):	6000
AHRI Ref #:		SEER - EER@95:	14 - 11.5
		Heat Pump HSPF:	9.5

Summary

MJ8 Calculations		Status	Equipment Capacities	
Sensible Gain (btuh):	16326	Sufficient	Sensible Capacity (btuh):	18000
Latent Gain (btuh):	4933	Sufficient	Latent Capacity (btuh):	6000
Total Heat Gain (btuh):	21259	Sufficient	Total Capacity (btuh):	24000
Heat Loss (btuh):	8236	Not Sufficient	Heating Capacity (btuh):	

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Green Acre Boarding MCSO IR 14-014274
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Gilbert , AZ 85298

Sales Consultant: Ron
Job#: 1005-1
Date: 07/11/2014

System I CFM

Duct sizes and velocities based on settings selected in the setup screen.

Item Name	Return Velocity	RA Duct Size	Supply Velocity	SA Duct Size	Winter Calculated CFM	Summer Calculated CFM	Winter System CFM	Summer System CFM
	*Duct sizes calculated using this CFM.							
System I	0		0		150	742	0	*0
Closet	0		0		25	39	0	*0
Daughters Bedroom	0		0		97	272	0	*0
Dog Room	0		0		27	432	0	*0

APPENDIX 4. HVAC CALCULATIONS WITH 20 DOGS IN ROOM

Ron Ballard
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602-228-7752 - ronnsue2010@hotmail.com

Green Acre Boarding MCSO IR 14-014274
15723 E. Appleby
Gilbert , AZ 85298

Sales Consultant: Ron
Job#: 1005-2
Date: 07/11/2014

System I (Average Load Procedure)

Design Conditions

Location:	Phoenix AP, Arizona		Elevation:	1133 ft	Daily Range: High
Input Data:	Outdoor Dry Bulb	Indoor Dry Bulb	Latitude:	33° N	Design Grains: -8
Summer:	108	75	Heated Area	454 Sq.Ft.	
Winter:	37	70	Cooled Area	454 Sq.Ft.	

Heat/Loss Summary (July Heat Load Calculations)

	Gross Area	Loss	Sensible Gain	Latent Gain
Walls	474.25	863	846	0
Windows	48	2012	2746	0
Doors	42	776	966	0
Ceilings	453.75	734	1225	0
Skylights	0	0	0	0
Floors	62	2024	0	0
Room Internal Loads		0	4600	3600
Blower Load			1707	0
Hot Water Piping Load		0	0	0
Winter Humidification Load		0	0	0
Infiltration		1361	714	-107
Ventilation		0	0	0
Duct Loss/Gain EHLF=0.06 ESGF=0.13		466	1443	0
AED Excursion		n/a	0	n/a
Subtotal		8236	14247	3493

Total Heating	8236	Btuh
Total Cooling	17740	Btuh

Approved ACCA MJ8 Calculations

17 Linear ft. of Hydronic Baseboard

*Calculations are based on the ACCA Manual J 8th Edition and are approved by ACCA. All computed calculations are estimates based on building use, weather data, and inputted values such as R-Values, window types, duct loss, etc. Equipment selection should meet both the latent and sensible gain as well as building heat loss.

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Green Acre Boarding MCSO IR 14-014274
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Gilbert , AZ 85298

Sales Consultant: Ron
Job#: 1005-2
Date: 07/11/2014

Equipment Selection

Design Conditions

Design Location:	Phoenix AP, Arizona	Relative Humidity:	45%
Elevation:	1133 ft	Summer Outdoor Design:	108
Latitude:	33° N	Winter Outdoor Design:	37
Daily Range:	High	Summer Indoor Design:	75
Design Grains	-8	Winter Indoor Design:	70

Heating Equipment

Mfg:		Altitude Correction Factor:	.04
Model:		Heating Input (btuh):	
AHRI Ref #:		Heating Output (btuh):	
Efficiency (AFUE):		Calculated HeatPump Output @ Design (btuh):	

Cooling Equipment

Mfg:	Rheem	Altitude Correction Factor:	.03
Oudoor Unit Model:	RQMA-A024JK	Rated Total Cooling (btuh):	24000
Coil:		Sensible Cooling (btuh):	18000
Furnace:		Latent Cooling (btuh):	6000
AHRI Ref #:		SEER - EER@95:	14 - 11.5
		Heat Pump HSPF:	9.5

Summary

MJ8 Calculations		Status	Equipment Capacities	
Sensible Gain (btuh):	14247	Sufficient	Sensible Capacity (btuh):	18000
Latent Gain (btuh):	3493	Sufficient	Latent Capacity (btuh):	6000
Total Heat Gain (btuh):	17740	Sufficient	Total Capacity (btuh):	24000
Heat Loss (btuh):	8236	Not Sufficient	Heating Capacity (btuh):	

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Green Acre Boarding MCSO IR 14-014274
15723 E. Appleby
Gilbert , AZ 85298

Sales Consultant: Ron
Job#: 1005-2
Date: 07/11/2014

System I CFM

Duct sizes and velocities based on settings selected in the setup screen.

Item Name	Return Velocity	RA Duct Size	Supply Velocity	SA Duct Size	Winter Calculated CFM	Summer Calculated CFM	Winter System CFM	Summer System CFM
	*Duct sizes calculated using this CFM.							
System I	0		0		150	648	0	*0
Closet	0		0		25	39	0	*0
Daughters Bedroom	0		0		97	277	0	*0
Dog Room	0		0		27	332	0	*0

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WWW.EFXFORENSICS.COM

GEORGE J. HOGGE PE

EDUCATION

Numerous Continuing Educational classes and seminars

B.S. Electrical Engineering: Arizona State University, Grad 1989

Classes in National Electrical Code, Electrical Inspections, Electronics; Gateway Community College 1982

EMPLOYMENT

October 2004 Present	Engineering Forensics Experts LLC *President/Principal Forensic Electrical Engineer*
October 2004 December 2006	Jerry James & Associates Fire Investigations LLC *Managing Partner/Principal Forensic Electrical Engineer*
February 1998 2006	BTI Consultants *Adjunct Consulting Forensic Engineer*
June 2001 October 2004	Engineering & Fire Investigations (now EFI Global) *Senior Forensic Electrical Engineer*
January 2000 June 2001	TOR Engineering *Electrical Engineering Manager*
June 1999 January 2000	GJH Engineering *Owner, Design and Consulting Firm*
May 1990 June 1999	Salt River Project *Senior Engineer, Inspections Supervisor, Distribution Design*
January 1990 May 1990	TOR Engineering *Engineer, Distribution Design*
May 1985 January 1990	GJH Electrical Design and Construction *Design/Build Electrical Contractor while attending ASU*
1979 to May 1985 1975 to 1979	Various Electrical Contractors including self *Journeyman Electrician and Electrical Design/Build Contractor* *Electrician Apprentice*

LICENSES

State of Arizona

- Registered Professional Engineer 28871

State of Colorado

- Registered Professional Engineer 35940

State of California

- Registered Professional Engineer 35940

State of Nevada

- Registered Professional Engineer 015229

State of New Mexico

- Registered Professional Engineer 5408

State of Utah

- Registered Professional Engineer 987935-2202

State of Wyoming

- Registered Professional Engineer PE 9511

National Council of Examiners for Engineering and Surveying (NCEES)

- Record # 26090 (Facilitates PE reciprocation for all states)

Arizona Electrical Contractor License

- Certified as Qualifying Party for Salt River Project ~ 1995 – 1999
- Certified as Qualifying Party for self ~ 1985-1989

EXPERT TESTIMONY EXPERIENCE

Deposition
Allstate Insurance and Hampton Braun VS Salt River Project
Salt River Project Law Department
Maricopa County, Arizona Cause #CV 1995-011100
1995

Deposition File No. 48120
Strozykowski, Tamara, VS Simplimatic Engineering
Burnett & Williams, PC
Virginia Circuit Court of Frederick County at Law #97-205
July 1999

Deposition File No. 49098
Ohio Casualty Insurance VS Delani Electric/Merkley
Tryon, Heller & Rayes, PC
Maricopa County, Arizona Cause #CV 98-15858
November 1999

Deposition File No. 94603-18626
Pinelli VS Colonial Electric
Horton, Barbaro & Reilly
Superior Court of California, County of Los Angeles Cause #BC224299
November 2001

Court Testimony File No. 94603-00373
State Farm Mutual Automobile Insurance Company VS Howell Enterprises Inc
Burrell & Seletos
South Mesa Justice Court, August 2003

Deposition File No. 1984-010705
Farmers Insurance Company VS Sun Devil Auto Parts Inc
Belknap and Sterling
Maricopa County, Arizona Cause #CV 2004-005717
February 2005

Deposition File No. 2026-012105
State Farm VS General Electric
Sittu Law Firm
Maricopa County, Arizona Cause #CV 2004-012838
April 2005

Court Testimony
Linda Garner VS St. Johns Palms et al
Koeller, Nebeker, Carlson and Haluck, LLC
Maricopa County, Arizona Cause # C 2003-2967
May 2005

Deposition BTI File # 54108
Rosa Cantu VS W.P. Murphy Inc
Maloney & Campolo, LLP
Bexar County, Texas Cause # 2003-CI-18750
May 2005

Deposition File No. 2218-031105
Farmers Insurance VS Cadet Manufacturing Company
Evizich Law Offices, PLLC
King County, Washington Cause # 04-2-36615-1 SEA
October 2005

Deposition File No. 2450-052305
Fireman's Fund VS Double Q Electric and Nedbo Construction
White and Steele, PC
Eagle County, CO District Court Case # 04CV477
November 2005

Deposition File No. 2728-080305
Lujan/Southwest Gas/Salazar VS Four Threes MHP, Teufel et al
Chandler & Udall, LLP
Pima County Superior Court Case # C2003 2328
December 2005

Deposition
Panda Express Inc VS Excel Construction
Kirton & McConkie
Utah District Court Case # 2:04-CV-579 TS
March 2006

Court Testimony
Panda Express Inc VS Excel Construction
Kirton & McConkie
Utah District Court Case # 2:04-CV-579 TS
June 2006

Deposition
One Beacon Insurance Company VS Elcon Electrical Contractors Inc
Cozen O'Conner
Socorro County, New Mexico 7th Judicial District Case # D-0725-CV-2004-65
June 2006

Deposition
Universal Underwriters VS Ford Motor Company
Magnum, Wall, Stoops, and Warden, PLLC
Coconino County, Arizona Superior Court Case # CV 2005-0101
September 2006

Deposition
Sidney and Tammy Leyendekker VS Precision Ag and Roto-Mix
Evans, Craven & Lackie
Yakima County, Washington Superior Court Case # 05-2-03909-3
September 2006

Deposition
Vera Haribedian VS Kendall J. Beltnick, et al
Fieger, Fieger, Kenney, & Johnson
Circuit Court, County of Isabella, State of Michigan Cause # 05-4568-NO
October 2006

Court Testimony
State Farm Insurance V. General Electric
The Sittu Law Firm PLLC
Maricopa County, Arizona Superior Court Case # CV2004-012838
November 2006

Deposition
Ward, Ervin VS Terex-Telelect, Et Al
Bryan L. Query and Estevan A. Aguilar
District Court of New Mexico CIV-05-198 RLP LFG
December 2006

Deposition
State Farm Fire and Casualty VS Broan Manufacturing Co.
Law Office of Dennis A. Sever, PLLC
US District Court for District of Arizona Cause # CV-00889-PHX-SMM
February 2007

Deposition
Rohrbacker, et al. VS Engineering and Fire Investigations et al.
O' Connor & Campbell PC
Superior Court of Arizona, County of Maricopa Cause # CV2005-007458
February 2007

Deposition
Kendis Kowal VS Maytag.
Quarles and Brady LLP
US District Court for District of Arizona Cause # CV06-2195-PHX-RCB
August 2007

Deposition
Tanya Travis VS Burgess Norton.
Eaton and Sparks Law Office
District Court of Rogers County, State of Oklahoma Cause # CJ-2002-466
October, 2007

Court Testimony
Tanya Travis VS Burgess Norton.
Eaton and Sparks Law Office
District Court of Rogers County, State of Oklahoma Cause # CJ-2002-466
October, 2007

Deposition
Dharmesh Patel et al. v. GTE, et al.
Law Office of Ed Fitzhugh
Superior Court of the State of Arizona, County of Maricopa Case No. CV2004-092571
December, 2007

Court Testimony
Bass VS Empire Southwest.
Schneider & Onofry, P.C.
Superior Court of the State of Arizona, County of Maricopa Case No. CV2004-004798
January, 2008

Deposition
Allstate Property & Casualty Ins. Co. vs. Salton, Inc., et al.
Cozen O'Connor Attorneys
Superior Court of the State of Arizona, County of Maricopa Case No. CV2006-01384
February, 2008

Deposition
Travelers Property Casualty Co. VS. Broan Nutone, LLC
Tedford and Henry, LLP
United States District Court, District of Arizona Case No. CV07-01922-SRB
March, 2008

Deposition
Tucson Unified School District & St. Paul F&M VS Thomas Built Buses, Inc.
Cozen O'Connor
Superior Court of the State of Arizona, County of Pima Case No. C20056188
May, 2008

Deposition File name: Lester Family Trust
Allstate Property & Casualty Ins. Co. vs. Electrolux
Hammerman and Hultgren, P.C.
Superior Court of the State of Arizona, County of Apache Case No. CV2007-004
June, 2008

Deposition File name: Michealieu
Farmers Insurance Co of AZ v. Rob Planty, et al
Belknap and Sittu P.C.
Superior Court of the State of Arizona, County of Maricopa Case No. CV2007-052523
September, 2008

Deposition File name: Andrews
Farmers Insurance Co of AZ v. Allen Erb, et al
Belknap and Sittu P.C.
Superior Court of the State of Arizona, County of Maricopa Case No. CV2008-050446
September, 2008

Deposition File name: Gould
American Federation Insurance Co., v. Lasko Products, Inc.
Belknap and Sittu P.C.
United States District Court, District of Arizona, No. CIV08-0647-PHX-ECV
February 2009

Deposition File name: Rimsza
Farmers Insurance v. Haskins Electric
Belknap and Sittu P.C.
Superior Court of the State of Arizona, County of Maricopa Case No. CV 2008-050895
February 2009

Deposition File name: Kwans Chinese Buffet
Central Mutual Insurance v. Victory Refrigeration
Munck Carter LLP
Superior Court of the State of Arizona, County of Maricopa Case No. CV2008-051259
November 2009

Deposition File name: Redemptorist Society
Redemptorist Society v. Peter Schwabe; JL&S Electrical
Kopon Airdo
Superior Court of the State of Arizona, County of Pima Case No. C2007-5799
November 2009

Deposition File name: Rimsza
Farmers Insurance v. Brooks Hardwood Floors
Belknap and Sittu P.C.
Superior Court of the State of Arizona, County of Maricopa Case No. CV 2008-050895
December, 2009

Court Testimony File name: Rimsza
Farmers Insurance v. Brooks Hardwood Floors
Belknap and Sittu P.C.
Superior Court of the State of Arizona, County of Maricopa Case No. CV 2008-050895
December, 2009

Court Testimony File name: Burger
GMAC Insurance vs. Newmar Corporation
GMAC Insurance
Superior Court of the State of Arizona, County of Maricopa Case No. CV 2007-011622
February, 2010

Deposition File name: Frye
Allstate Insurance vs. Electrolux
Keis George LLP
US District Court, Northern District of Ohio Cause No. 1:09-cv-00674
April, 2010

Deposition File name: Woodruff
Farmers Insurance v. Schumacher Electric Corp.
Belknap and Sittu P.C.
United States District Court, District of Arizona Cause No. 09-01266 PHX MEA
June, 2010

Deposition File name: Opie
Douglas and Valerie Opie, v. Country Home Products/Neuton Inc.
Copple and Copple
United States District Court, District of Arizona Cause No. CIV-08-1716-PHX-DKD
January, 2011

Deposition File name: Sloan
Barbara A. Sloan vs. Farmers Insurance Co. of Arizona
Jones, Skelton, and Hochuli, P.L.C.
Superior Court of the State of Arizona, County of Maricopa Case No. CV2009-033244
June, 2011

Deposition File name: Munderloh
Mark and Liz Munderloh vs. Avista Utilities
Luvera Law Firm
Superior Court of the State of Washington, Spokane County Cause No. 10200874-2
June, 2011

Deposition File name: Kaip
Farmers Insurance v. Universal Metal Industries and Jakel Inc.
Law Office of Douglas A. Belknap PC
Superior Court of the State of Arizona, Co. of Maricopa Case No: CV 2010-054086
October, 2011

Deposition File name: Casey
Pacific Indemnity Co v. G.E.W. Corp. Inc.
Cozen O'Connor
Superior Court of the State of Arizona, Co. of Maricopa Case No" CV 209-036702
November, 2011

Deposition File name: Sloan
Barbara A. Sloan vs. Farmers Insurance Co. of Arizona
Jones, Skelton, and Hochuli, P.L.C.
Superior Court of the State of Arizona, County of Maricopa Case No. CV2009-033244
January, 2012

Deposition File name: Ashdown
Hartford v. Native Tucson Builders, Et al.
Garry, Woner, Hoffmaster & Peshek, P.C.
Superior Court of the State of Arizona, County of Pima Case No. C 2010-6129
March, 2012

Deposition File name (EFX): Ruud Lighting
John Libby v. Gary Lichte
The Moulton Law Firm, P.C.
Superior Court of the State of Arizona, County of Pima Case No. C 2010-7776
June, 2012

Deposition File name: Howard
Tony Howard vs. Broan Nutone, LLC
Matthew P. Bonham, Esq.
U.S. District Court, Northern District of Georgia, Gainesville Division
Civil Action File No. 2:10-cv-0195-RWS
December, 2012

Court Testimony File name: Rauch
Clark County vs. Charles Rauch
Kocka and Bolton
Superior Court of the State of Nevada, County of Clark, Case No. C268231
January 2013

Deposition File name: Clean Cut Lawns
State Auto Property and Casualty Ins. vs. Broan Nutone, LLC
Ted Frapoli, Esq.
U.S. District Court, District of Arizona, Case No. 2:13-CV-00752-DKD
January, 2014

COURSES INSTRUCTED

Design of Overhead and Underground 12kv Distribution Systems – Salt River Project
1995, 1996, 1997, 1998

Design of Underground Electrical and Gas Systems – TOR Engineering, 2000

Transformer Application and Sizing – Salt River Project
1996, 1997, 1998

Applications of National Electrical Code – Salt River Project
1995, 1996, 1997, 1998

Applications of National Electrical Safety Code – Salt River Project
1995, 1996, 1997, 1998

NFPA 921 Chapter 8 – Phoenix Fire Dept. 2010

"Elimination of Electrical Fire Causes" – Phoenix Fire Dept. 2011

PRINCIPAL AREAS OF RESEARCH AND CONSULTING EXPERIENCE

~Forensic Electrical Engineering

~Electrical Fire Causes, Injuries, and Fatalities

~Electrical Failures and Explosions

~Auto and Machinery Electrical Systems

~Water Intrusion Investigations

~Residential, Commercial, and Industrial Electrical Distribution Systems

~Industrial Electrical Controls and Instrumentation Systems

~National Electric Code

~National Electric Safety Code

~Engineering, Design and Construction Management of Overhead and Underground High Voltage Electrical Distribution Facilities

~Design of Fiber Optic Facilities Associated with Electrical Distribution

~Design of Underground Gas Facilities

~Maintenance and Reliability of Overhead Power Facilities

~Electrical Substation Design and Construction Management

~Trenching and Boring Inspections and Safety Practices

~Journeyman Electrician and Electrical Contractor

PROFESSIONAL ORGANIZATION MEMBERSHIPS

IEEE – Institute of Electrical and Electronics Engineers

NFPA- National Fire Protection Association

IAAI – International Association of Arson Investigators

SAE – Society of Automotive Engineers

USERC – Utility Service Entrance Requirements Committee

AEI – Association of Electrical Inspectors

PACN – Phoenix Area Consultants Network

CTFIA-Central Texas Fire Investigators Association

GETTY ENGINEERING Services, Inc.

6929 N. Hayden Road
C4 #605
Scottsdale, AZ 85250
480-607-1808

CURRICULUM VITAE

RON BALLARD, MS

CURRENT POSITION

HVAC (Heating, Ventilation and Air Conditioning) retired contractor
HVAC & Engineering Technician

EDUCATION

1963-1967 Mankato State College
Mankato, MN
Bachelor of Science, Elementary Education

Major areas of study:
Elementary Education with an area of concentration in Social Studies and a minor in History

1969-1970 Mankato State College
Mankato, MN
Master of Science, Elementary Education

Major areas of study:
Science

CERTIFICATION

1967 State of Minnesota - Teaching Certificate

1970 State of Arizona – Teaching Certificate

1985 State of Arizona – Air Conditioning and Refrigeration License #ROC 187237

SPECIALIZEDTRAINING & Education

1981 Phoenix, AZ - RSI (The Refrigeration School)
Honor Roll Certificate

TRANE: Seminars and/or training – multiple business and technical classes on new and existing equipment

CARRIER: Seminars and/or training – multiple business and technical classes on new and existing equipment

EXPERIENCE

2011-present Engineering and HVAC technician
GETTY ENGINEERING Services

HVAC Analysis
Performance & troubleshooting of HVAC equipment
Determination of HVAC operability
Evaluation of reparability or replacement of condenser coils & fins
Wind damage documentation
Hail damage documentation
Roof inspections
Repair or Replace recommendations
HVAC equipment
. Commercial
. Residential

1982 – 2010 HVAC contractor
BALLARD A/C & HEATING, LLC

Owner and principal operator of Ballard A/C & Heating for 28 years
Repair and/or Replace HVAC equipment
. Commercial
. Residential
Supervised, trained and motivated all staff in the field
Responsible for consulting on and writing up all proposals for work
Responsible for all aspects of marketing and business decisions including the introduction of a monthly newsletter mailing

1976-1984 Hale Elementary School, Mesa, AZ

Taught 5th grade general studies including math, spelling and science
Prominent science instructor for all three 5th grade classes for eight years
Stressed importance of problem solving to encourage motivation and independence

1970-1976 Longfellow Elementary School, Mesa, AZ

Taught 5th grade general studies including math, spelling, social studies, language arts and science

1967-1969 Le Sueur Public School, Le Sueur, MN

Taught 5th grade general studies including math, spelling, social studies, language arts and science

1959 – 1961 US Navy – ABU-3, Honorable discharge

PROFESSIONAL ASSOCIATIONS

RSES (Refrigeration Service Engineers Society)

Carrier Corporation Factory Authorized Dealer (1st established dealer in Arizona)

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