THE IMPACT OF AIR DISTRIBUTION SYSTEM LEAKAGE ON HEATING ENERGY CONSUMPTION IN ARKANSAS HOMES

Technical Supplement II: Pressure Pan Procedures for Finding Leaks And Confirming Their Repair

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TABLE OF CONTENTS

BACKGROUND

PROCEDURES

GRAPHS OF STUDY PRESSURE PAN READINGS

DISCUSSION OF THE PROCEDURE

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BACKGROUND

By the fall of 1990, Home Comfort had finally gotten to the field test stage and was testing houses for air distribution system leakage. The field tests were interrupted by my presentation at a weatherization conference. As is often the case, friends show up who were also conference presenters. In this case, it was John Tooley of Natural Florida Retrofit. He showed me a bread pan that he had modified and was using to take pressure differential readings between a room and its wall cavity. The multiple applications of this were stunning.

Returning home, I decided to try his concept in the study we had just begun. After spending an hour browsing through several different sections of the local Wal-Mart store, I headed back to the workshop with a 10" x 14" aluminum cake pan, a plastic drawer pull and some hardware washers. At the workshop, I added some gasket material, a length of blower door gauge hose, mastic and drilled some holes. The result was a gasketed cover with a handle and a pressure tap that would cover most supply registers. This low tech cover was hooked up to our high-tech electronic multimeter. Now we could take quick pressure differential readings at each register when the blower door was operating. Taping a large piece of paper over the return register and poking a hole would give a reading for the return. At this stage, it was simply a concept.

All kinds and sizes of pressure pans have been built since. Stainless steel salad bowls for round registers, large shields for returns, pressure pans with interchangeable handles and

extension poles for ceiling and high sidewall registers. We are currently manufacturing them from our stock of acrylic panels and aluminum framing.

In the first field use it was immediately clear that the pressure pan readings would be very useful. Almost all the pressure pan differential readings were below .9 Pascals, but the measurement at the return register was 14.0 Pascals. The readings strongly indicated that most of the leakage in this system was in the return. Time consuming visual inspection finally confirmed that as probably true. (In the repair phase of our study it was established as true.)

From that point on, pressure pan readings were taken to diagnose the location of important system leakage and to confirm that repairs had been successful or that more repair was necessary.

PROCEDURES

Briefly examine house to understand it.

Check for combustion safety.

Check for health concerns.

Check for moisture/durability concerns.

Check operation of system.

Set up house as for blower door test.

Turn on system and record pressure differential between inside and outside.

Turn off system.

Remove filter from system and make sure that all registers are fully open.

Operate blower door and create a negative 30 Pascal pressure differential between inside and outside. **[Please note that we now use 50 Pascals of pressure difference]**

Cover each register one (1) at a time and record pressure pan reading.

Run blower door test.

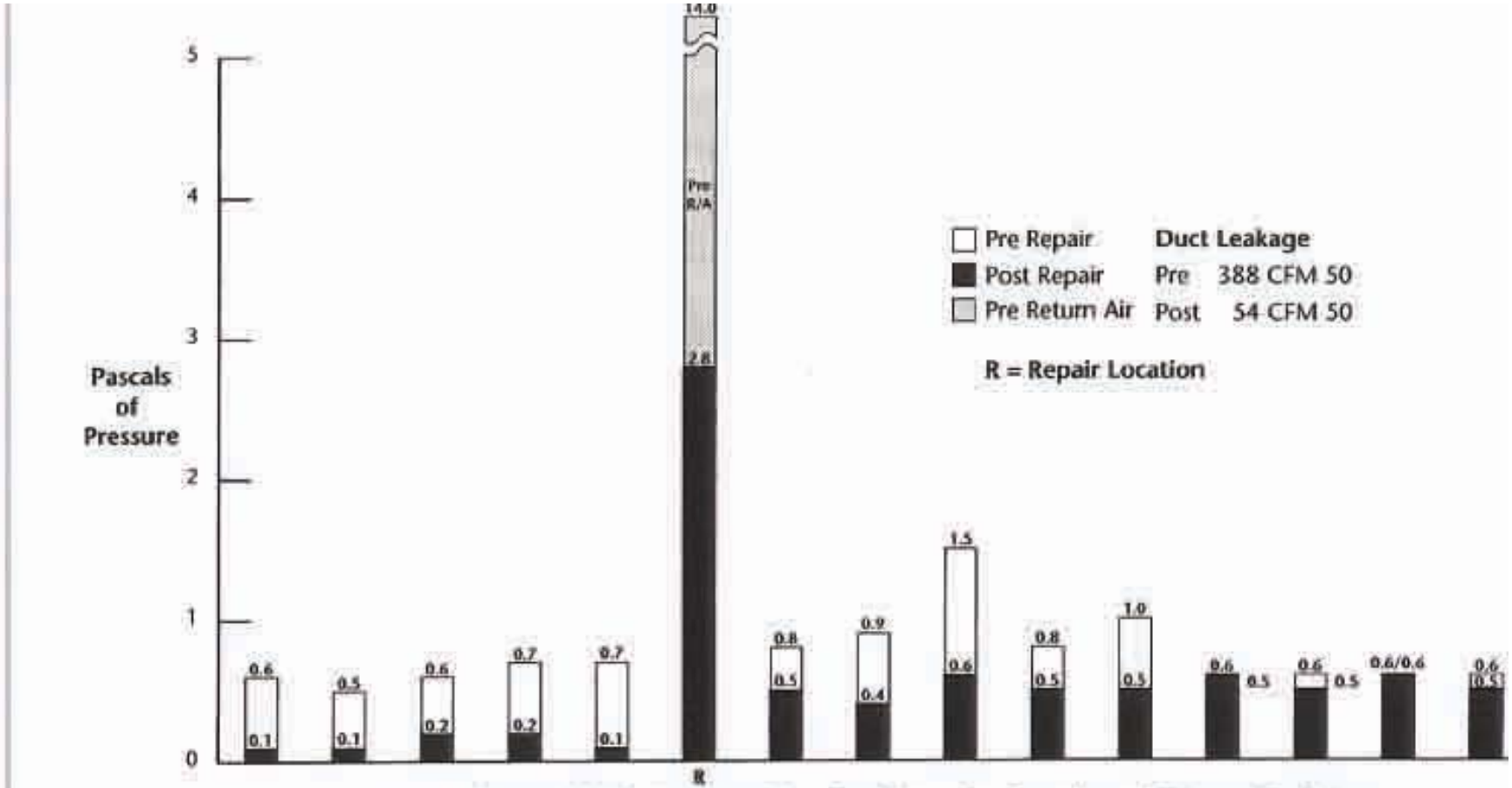
Return house and all equipment to normal conditions and settings.

GRAPHS OF STUDY

PRESSURE PAN READINGS

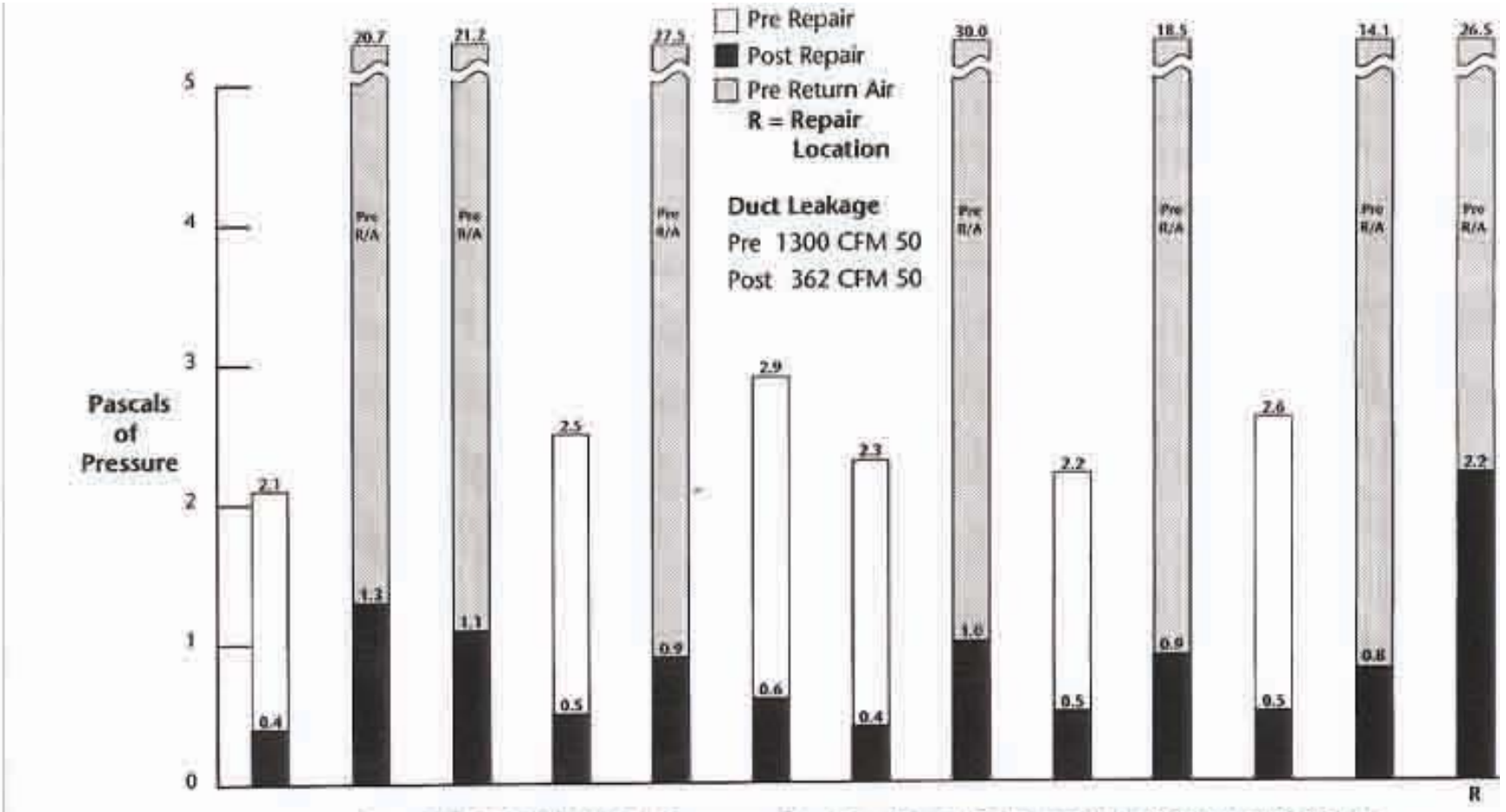
A graph has been created for each of ten (10) houses in the study that have both pre and post repair readings. Each register is represented by an overlaid bar graph so that pre and post readings for each register can easily be compared as well as comparing one (1) register to another. The return(s) are identified (R/A), and an R is placed below each register that received repair in that area of the system.

If additional repairs were made, a statement is provided below the graph. Take some time to become familiar with the graphs and then turn to the discussion that follows.



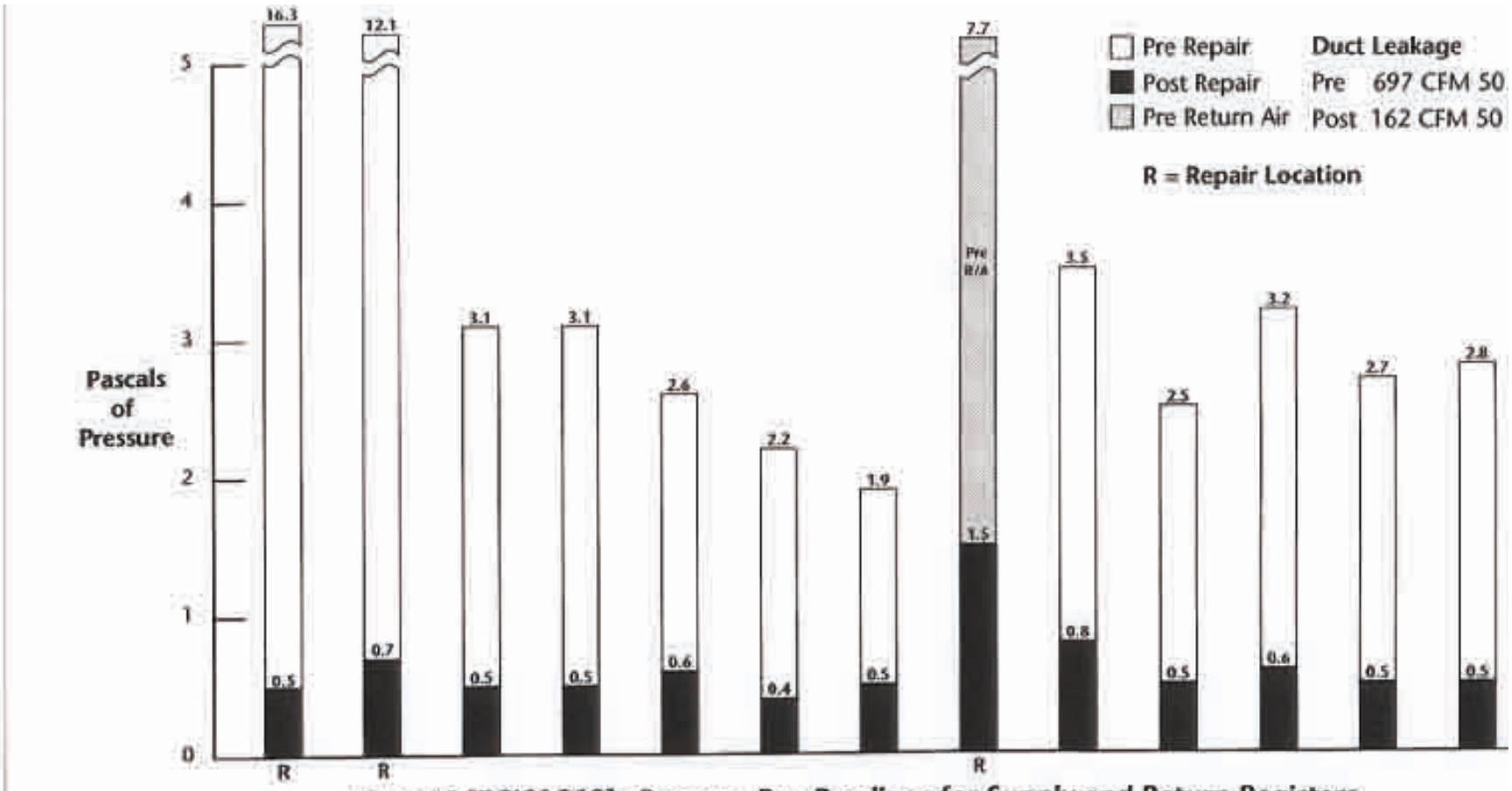
Case #1 [MILL1G07]: Pressure Pan Readings for Supply and Return Registers.

Wall and second floor truss cavities were incorporated into return air path.



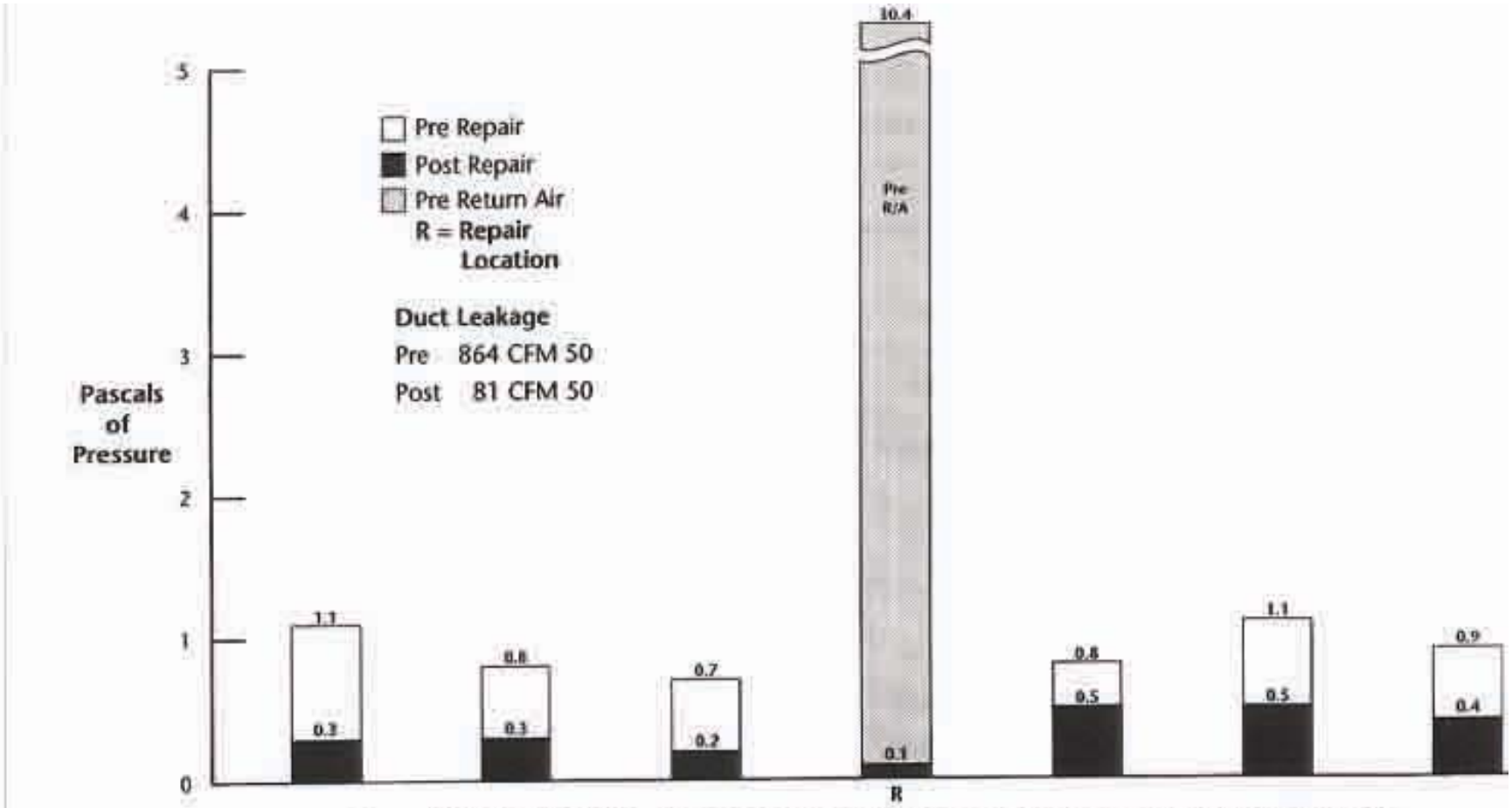
Case #4 [BROW1G14]: Pressure Pan Readings for Supply and Return Registers.

Duct repair at return air plenum in crawlspace.



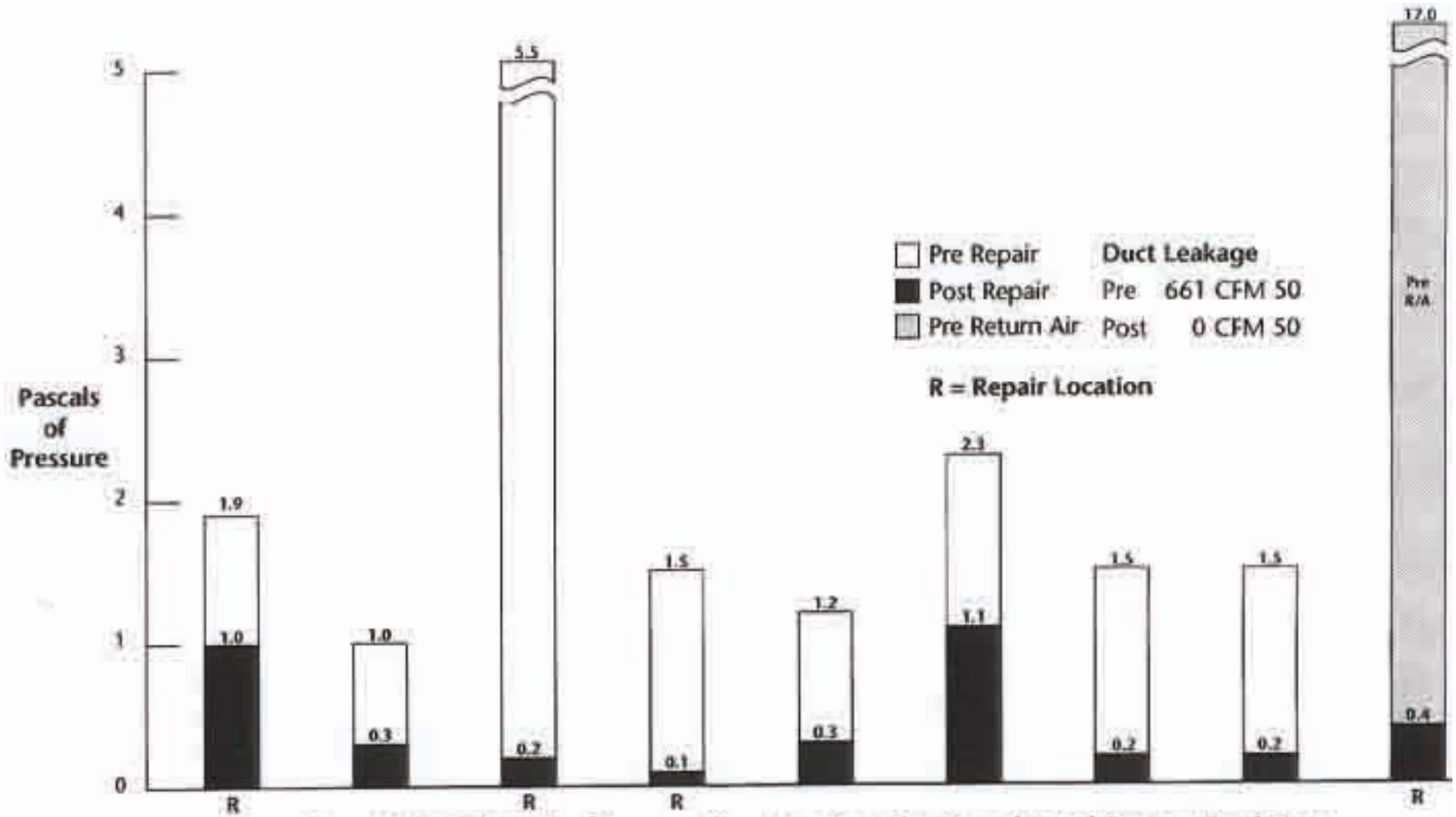
Case #5 [DEIS1G18]: Pressure Pan Readings for Supply and Return Registers.

Additional repair at finger joint connections where supply ducts take off from plenum.



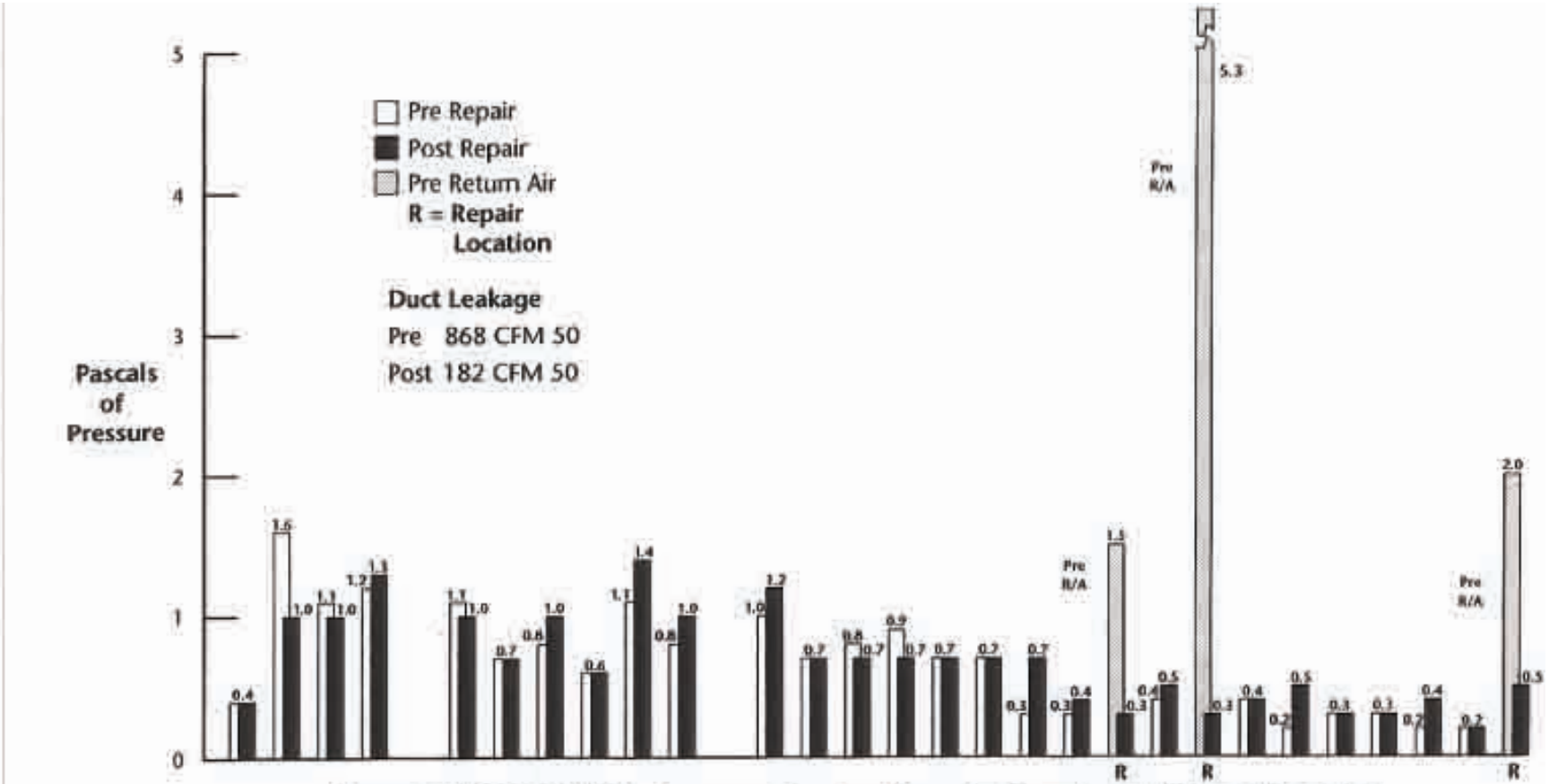
Case #8 [DENT1G12]: Pressure Pan Readings for Supply and Return Registers.

Minor air sealing of supply plenum to furnace.



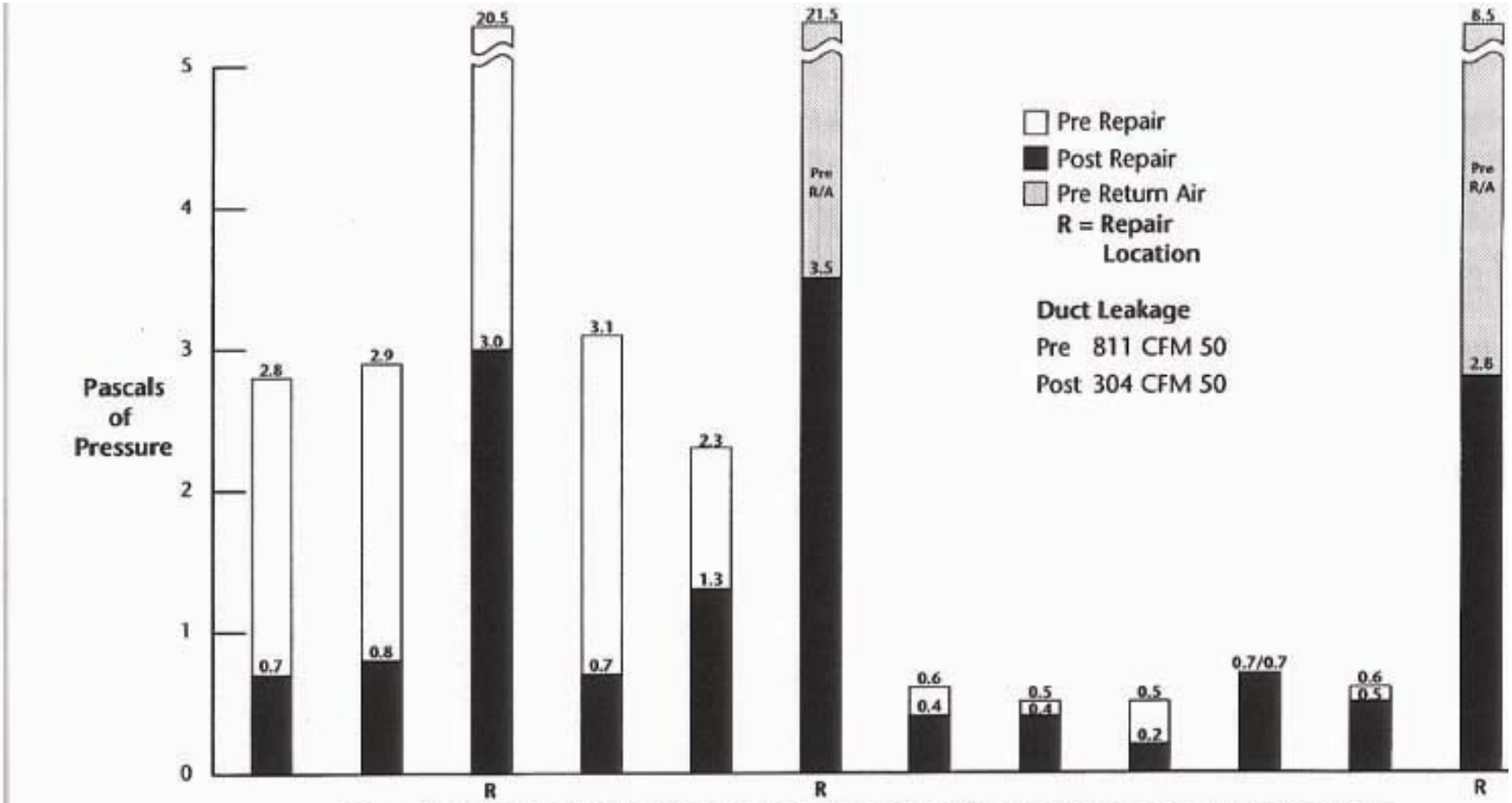
Case #9 [EISE1G11]: Pressure Pan Readings for Supply and Return Registers.

Additional sealing was completed at supply and return plenums.



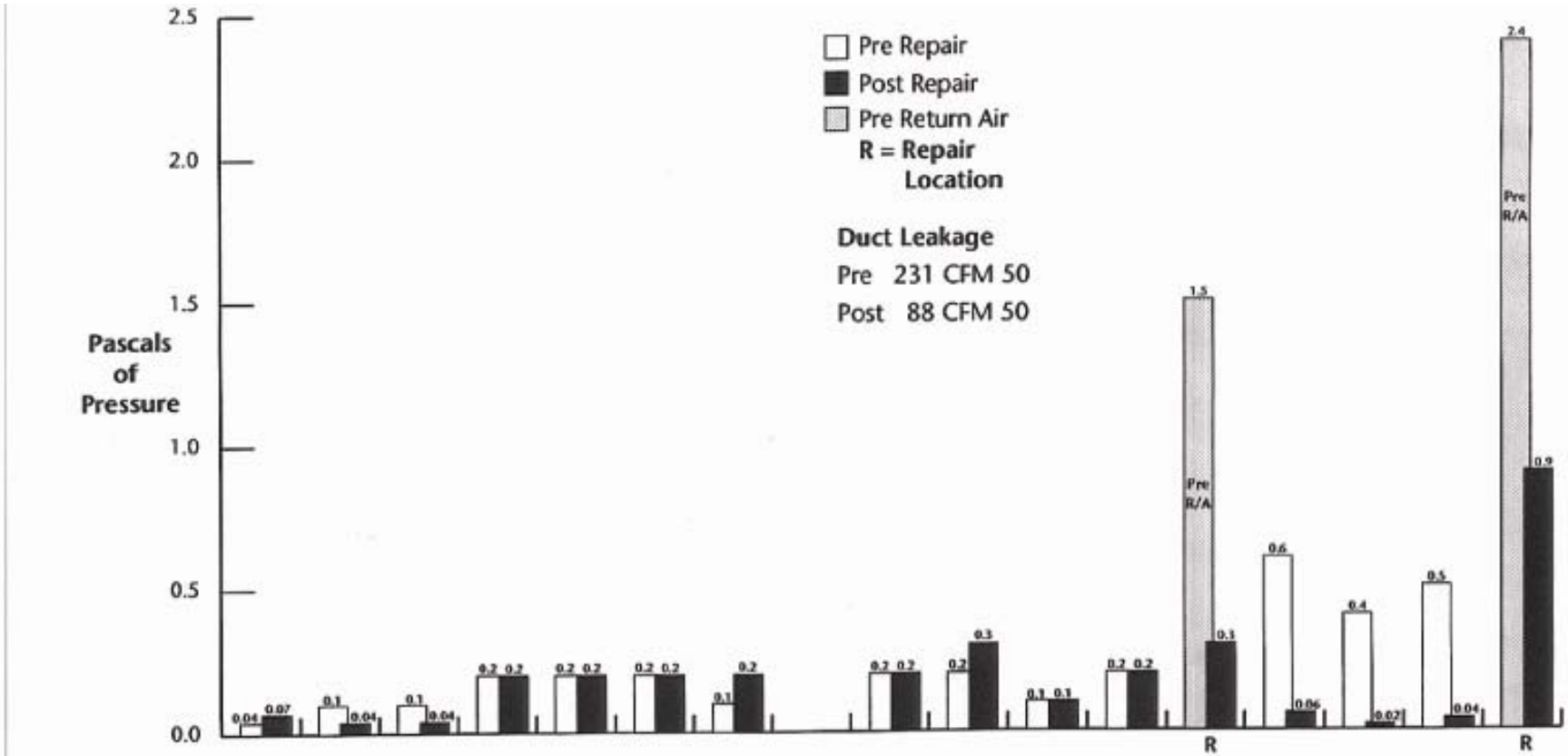
Case #11 [GOFO2E09]: Pressure Pan Readings for Supply and Return Registers.

Plus miscellaneous minor repair to crawlspace supply.



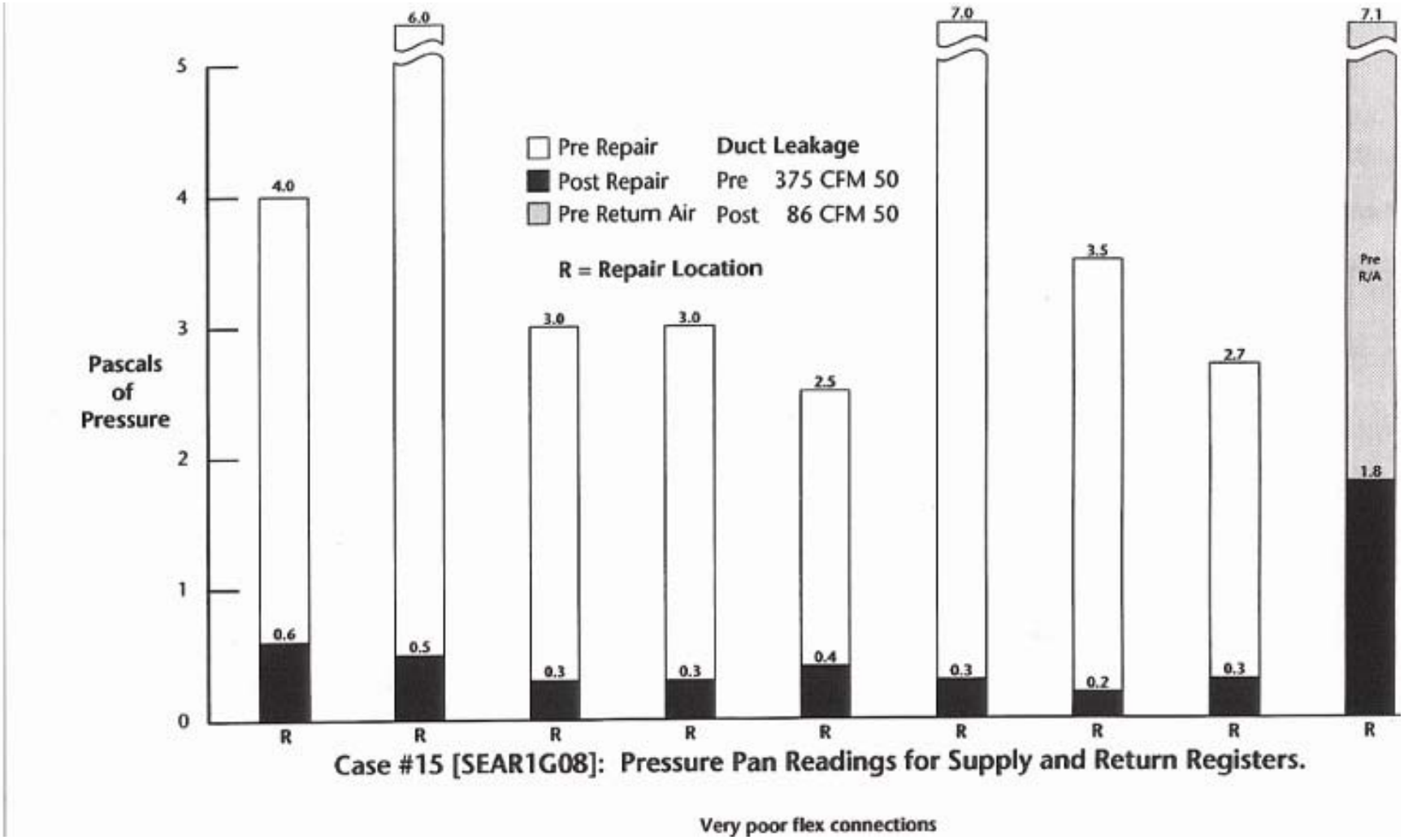
Case #12 [HALL2G17]: Pressure Pan Readings for Supply and Return Registers.

Additional sealing at supply and return plenums.



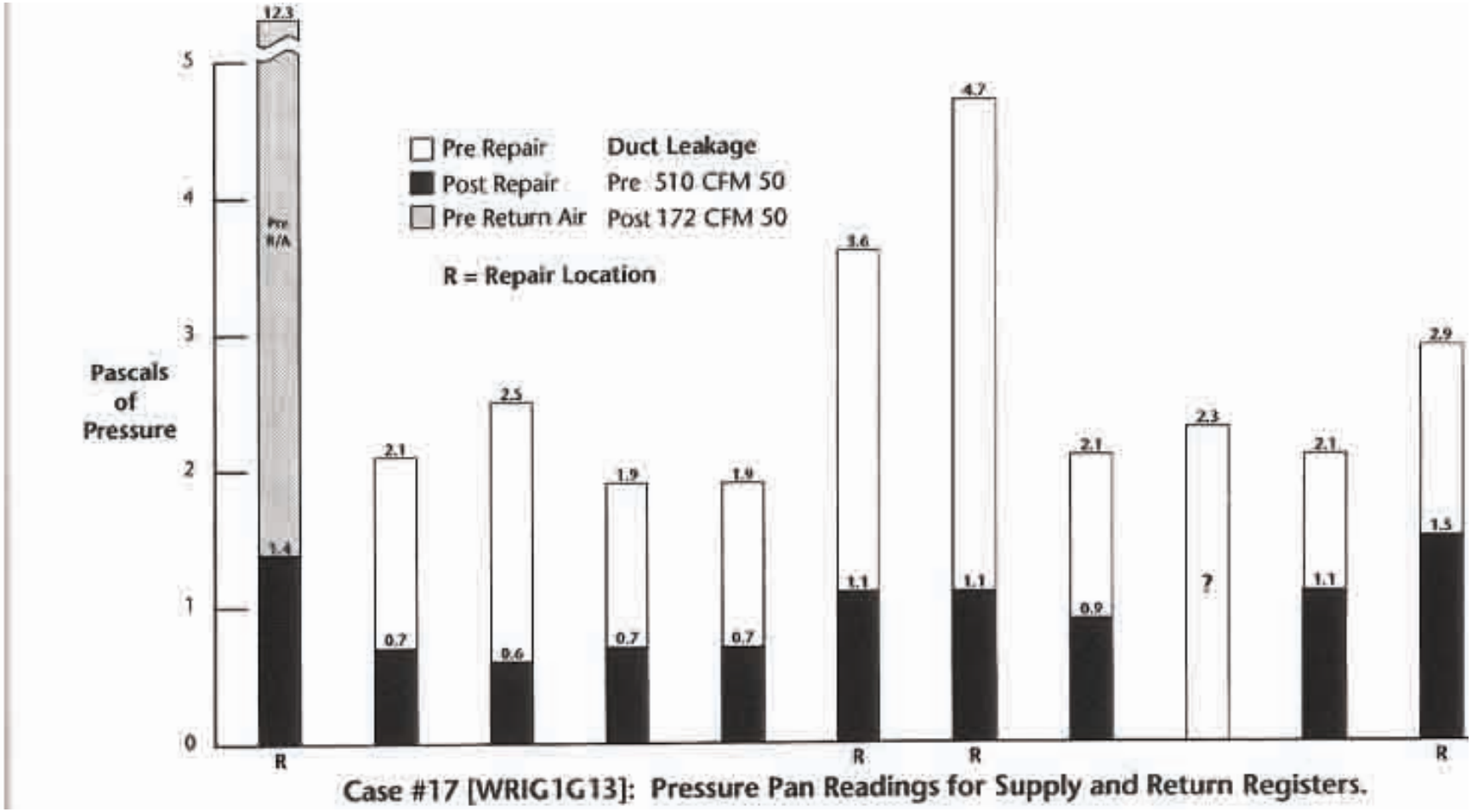
Case #14 [SCOT2E19]: Pressure Pan Readings for Supply and Return Registers.

Boot to ceiling sheetrock air seal on second unit.



Case #15 [SEAR1G08]: Pressure Pan Readings for Supply and Return Registers.

Very poor flex connections



Case #17 [WRIG1G13]: Pressure Pan Readings for Supply and Return Registers.

DISCUSSION OF THE PROCEDURES

Pressure pan readings give a repair technician quick, direct, reliable yet simple direction for successfully air sealing leakage in distribution systems. The information is relative information. It does not measure a specific amount of cubic feet of air leakage. However, if a system is completely air tight, the pressure pan readings would be zero.

Negative 30 Pascals was chosen simply as a convenient pressure. It is high enough to get good readings and low enough so that we can reach it in most houses. The readings indicate the proximity of significant leakage to each register. This allows the technician to concentrate the repair effort and ignore areas in the system that have only minor leakage.

The readings are interactive throughout the system. You can see in the graphs that repair to the areas with the dominate readings results in a drop for both the repaired areas and the registers that were ignored.

The number of openings in a system, the size of a system and the distribution of leakage sites within the system affect the relationship of pressure pan reading to actual cubic feet per minute of leakage left in an air distribution system. Readings showing the same pressures in two (2) systems can have different CFM50 air leakage. However, through the process of this study some points of reference have been chosen for residential systems.

1. The first goal is to reach .9 Pascals or less at each register. Don't worry about fractional readings, just concentrate first on the high readings. In most retrofit repair jobs, this goal is compatible with the target of only leaving around 150 CFM50 leakage in the distribution system.

2. The second goal is to reach .5 Pascals or less at each register. For existing systems that are receiving retrofit air sealing but not total repair, this is a significant level of air sealing.

3. The third goal is to reach below .1 Pascals at every register. This is completely possible with new installations or totally retrofitted systems. In some of our work on older homes, the ducts are uninsulated. It is simple to seal the system prior to installing the insulation.

4. As mentioned before, zero readings would mean no leakage. To achieve this would require taping the equipment panels, etc., or keeping the whole system inside the conditioned space. That is possible with electric furnace or heat pump air handlers and sealed combustion gas equipment.

Pressure pan readings are very useful because the process can proceed even on windy days. Trying to see a one (2) or two (2) Pascal pressure differential caused by an air handler is sometimes impossible on a windy day. That small Pascal pressure differential will not occur in a big or leaky house but pressure pan readings are right

there showing you where to work. Sometimes turning on the air handler results in a zero pressure differential because the supply and return leaks are equal. Pressure pan readings point out which return and which supply to air seal.

Some pressure pan readings do require interpretation. If the sheetmetal boot supplying the air to a room is installed with a large gap between it and the ceiling or floor, a portion of the reading will be direct outside air not leakage traveling down the duct. However, it is a quick fix that ought to be stopped anyway. In some houses where the owner closes registers, that hole is where the air coming down the duct is going when it can't enter the room.

Ordinary field blower door tests are crude, yet very practical in their approach to measuring CFM50 air leakage in air distribution systems. As the air flows are reduced from the standard gigantic flows to the smaller repaired system flows, the field test subtraction method becomes less and less able to provide correct CFM50 air leakage. This was obvious in some of the study houses. There was small air flow and in addition some wind which resulted in the blower door test subtraction method giving zero CFM50 left in the system. However, when we followed up with the pressure pan testing, readings were taken that showed that under ideal blower door testing procedures a CFM50 air flow would have been found.

While electronic multimeters are desirable for taking pressure pan readings, we have demonstrated in our experimentations that the standard Minneapolis Blower Door

gauges can provide, with practice, 1 Pascal, .5 Pascal and almost nothing Pascal readings.

This pressure pan procedure could make an excellent code enforcement tool. For example, prior to receiving certification for the heating and air conditioning system, pressure pan readings must test at .1 Pascal or less. Of course, the air sealing material must have twenty-five plus (25+) years of life, i.e., not tape, but mastic sealing. Equipment manufacturers must learn to build equipment with panels that really seal. This improvement also applies to connections for mating air handlers, air conditioning coils and plenums.

Another use for the pressure pan tests is for house efficiency ratings. Air distribution system leakage is all but totally missing from rating system calculations. This testing procedure can easily be integrated into the house review and certification process that raters use.

For research, you want detailed numbers and quantifiable equations to model and explain the total interactive process of a phenomenon and the ability to provide prediction.

For certification, diagnostics and repair services, you want to be the most effective under less than optimum conditions, with the least equipment and time as possible. You want results now. Pressure pan testing exquisitely meets these needs.

The evolution of the pressure pan procedure has just begun. Join in the fun and enjoy the creative process.