



THE 20TH INTERNATIONAL OPERATIONS & MAINTENANCE
CONFERENCE IN THE ARAB COUNTRIES

جامعة الملك عبد الله
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King Abdullah University of
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Energy Savings through Envelope Sealing

Biju Reghuvaran, Maintenance Lead, KAUST

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Agenda

- KAUST
- Building envelope
- Case study
 - The building
 - Sealing process
 - Results
- Conclusion



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King Abdullah University of Science and Technology (KAUST)

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King Salman bin Abdulaziz Royal Natural Reserve
محمية الملك سلمان بن عبدالعزيز الطبيعية

Medina
المدينة المنورة

Jeddah
جدة

King Abdullah University of Science...





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KAUST



Established in 2009

- One of the fastest growing research universities in the world
- Devoted to find solutions for some of the most pressing scientific and technological challenges
- High-quality research output ranked globally among its peers
- state-of-the-art research labs and facilities,
- expert academic staff, and a world-class curriculum

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KAUST Facility Management



Competent Team of skilled professionals

- With an ambition to save energy
- Focuses on reducing carbon footprints
- Implements Energy saving programs



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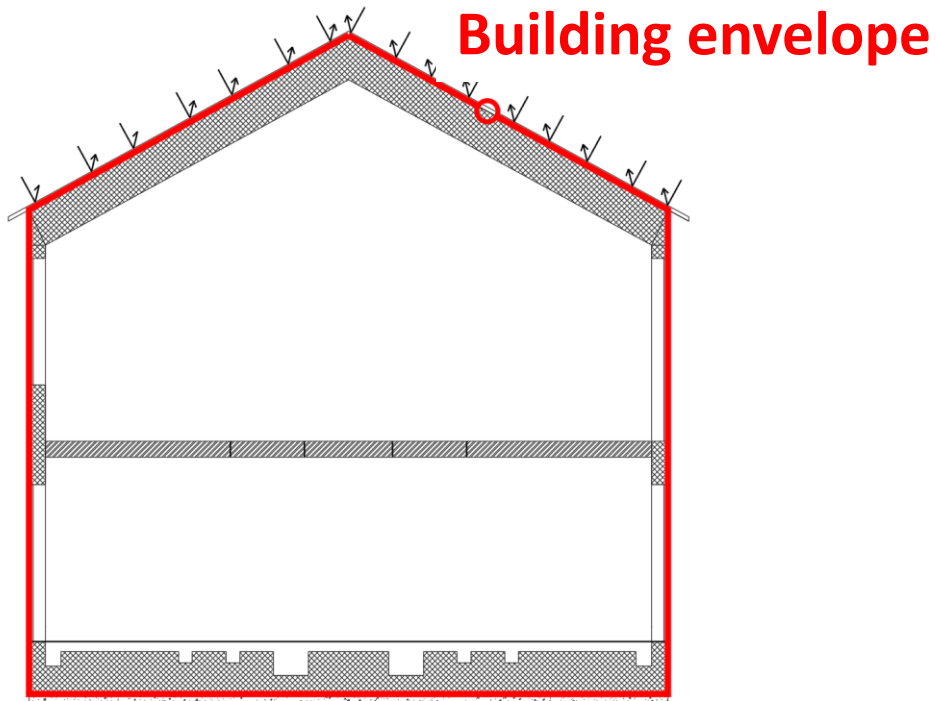
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Building Envelope



Building Envelope



- **Enclosure** of a built environment
- **Separates** the indoor environment of the building from the outdoor environment
- **Protects** building **interior** and occupants from the weather conditions and **external** elements
- An **efficient design** helps in achieving energy efficient and sustainable built forms



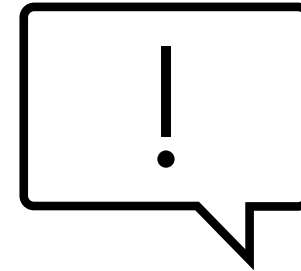
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Importance of Building Envelope

- Preserves internal environment
- Separates conditioned space from external environment
- Prevents ingress of air and loss of treated air
- Protects assets from deterioration due to mold, condensation



Tighter building envelope = Lesser energy loss



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Case Study



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Al Khawarizmi Building



- Home to the region's top performing supercomputer
- Includes Visualization labs and computing labs
- Work/study spaces for faculty, researchers and students
- Total Floor Area = 39,191 sqm. (421,848 sft.)
- Mechanical floor on level 5 = 6400 sqm.(68,889 sft.)





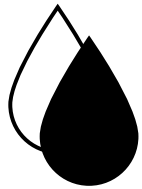
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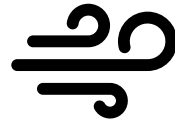


Location Challenges

Extreme weather conditions as the University is located on the Red Sea



High humidity



Strong winds



Temperature variation

To withstand the above a robust building envelope was designed and constructed



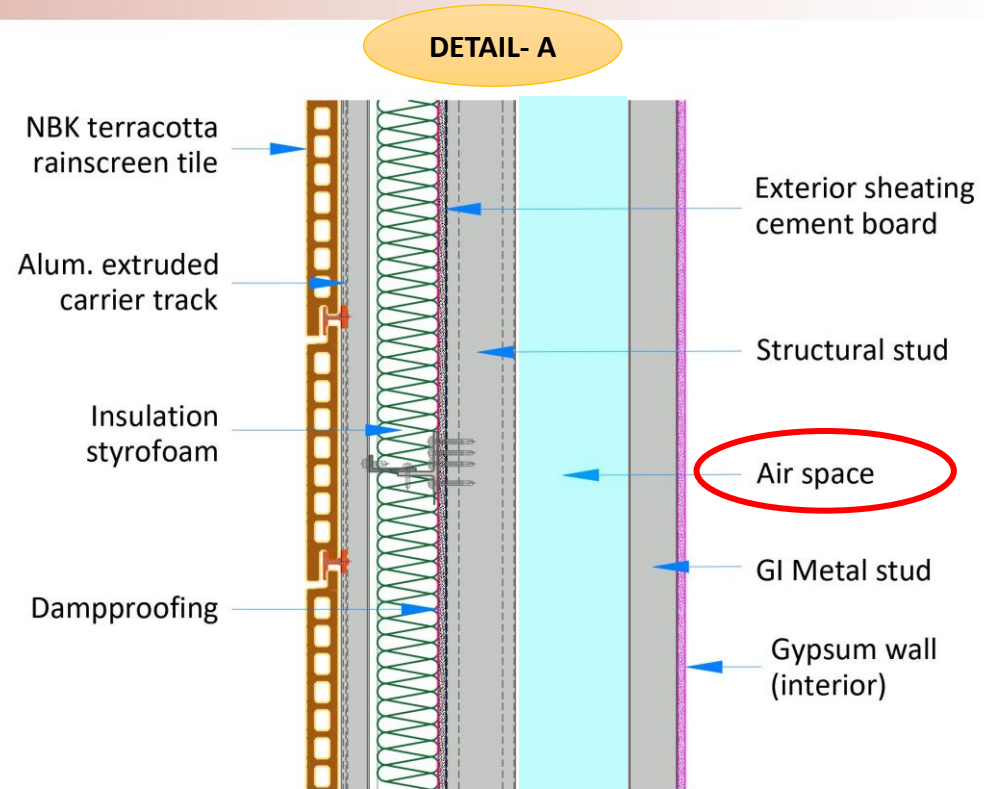
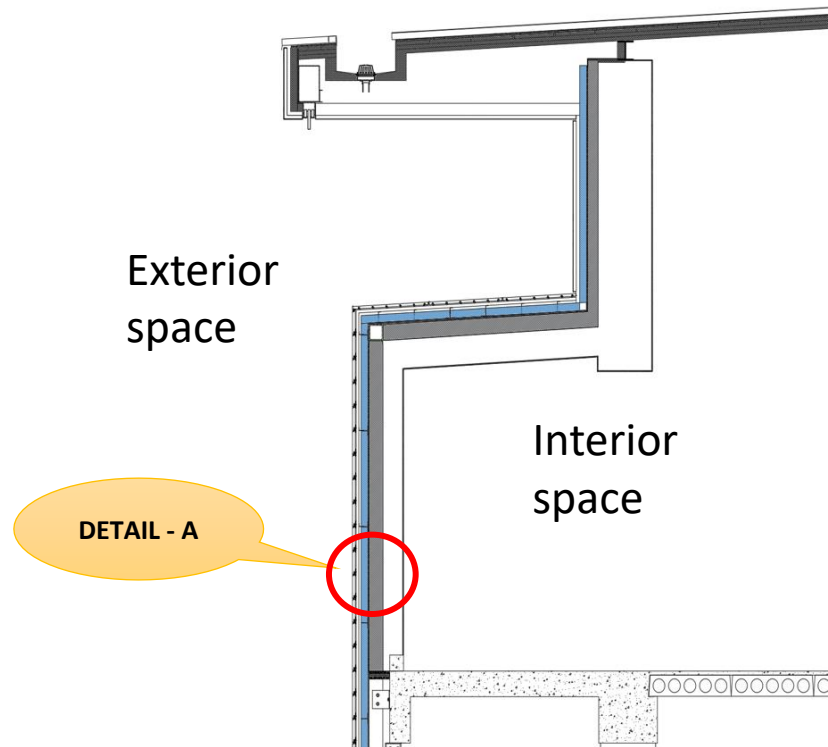
Challenges due to Construction

- Deficiencies in construction
- Deterioration of materials
- Type of installation
- Conduits and penetrations
- Maintenance works/ projects
- Inaccessibility



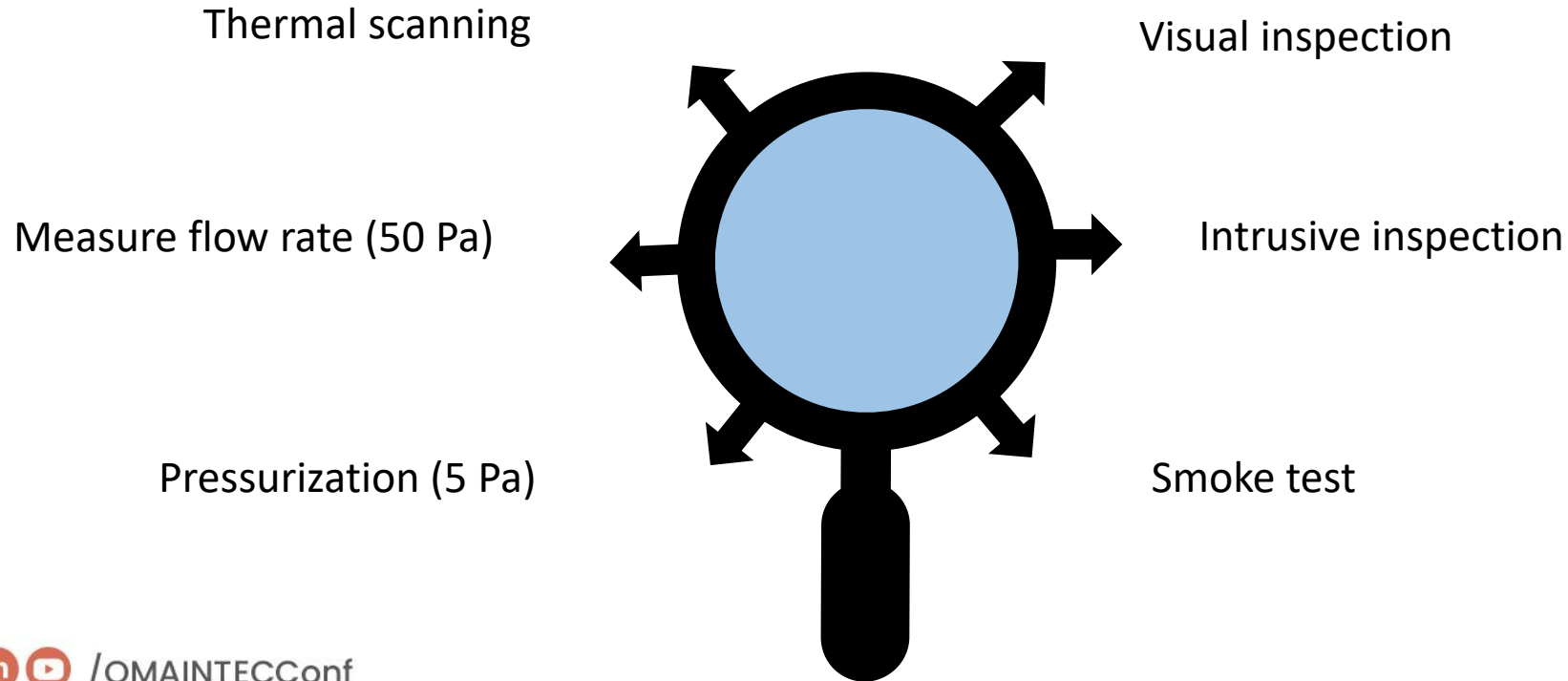


Building Envelope Section





Identification of defects



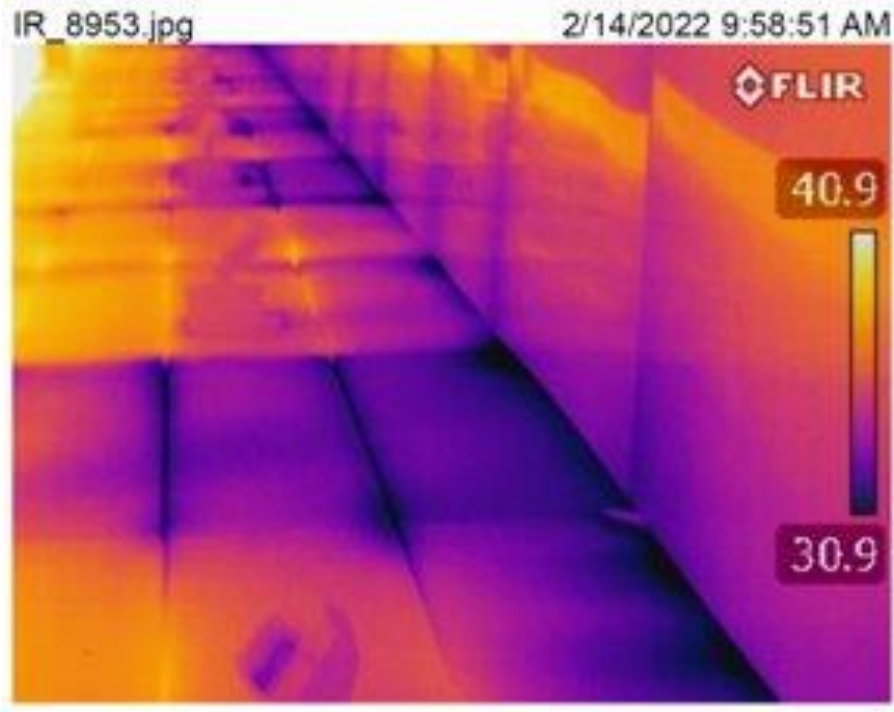


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Thermal Scanning





Defect Assessment

- Analysis of Thermal images
- Identification of cold spots
- Visual inspection of defects
- Closure of openings
- Rescanning



Sealing results were not satisfactory as new leakage locations were found !



Use of new technology

- Aeroseal® technology for sealing HVAC ducts
- Aerobarrier® technology (Waterborne acrylic sealant) for sealing building envelope
- Larger area in the range of 6400 sqm (68,889 sft.) was never tried in the Middle East





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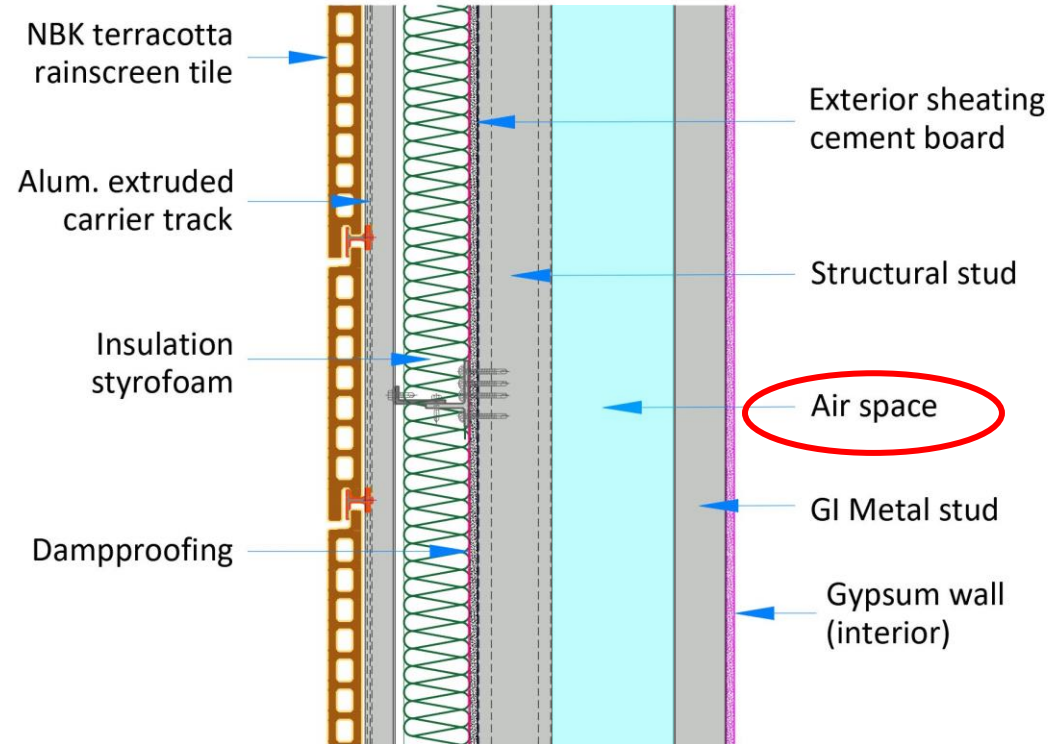


Advantages of the new method

- No impact on building occupants
- No need to build huge external scaffolding
- No need to remove cladding elements
- No impact on HVAC systems
- All works carried out from inside the building
- Seal even smallest gaps
- Shorter project execution time
- Warranty from contractor



Sealing process



Sealing process



Installation of
partitions



Manual sealing of
large visible openings



Blower door installation
and Pressurization test



Reinspection and
Manual sealing, if
required



Sealing process



Install Sealant stations

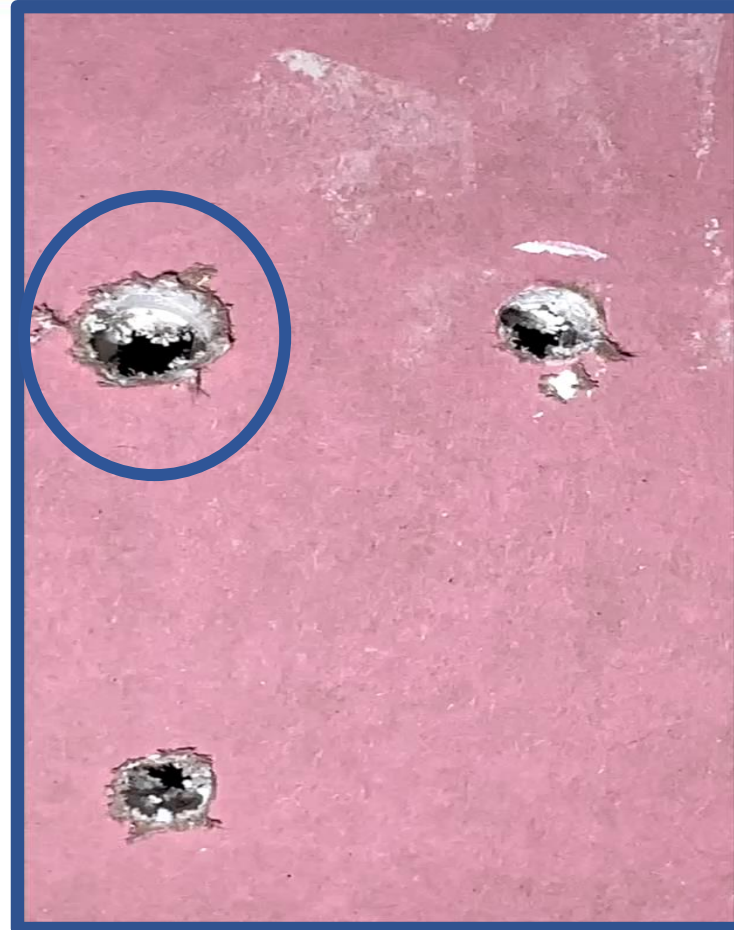
Sealing process





Sealing process

Pressurization and Sealant application



Envelope Postseal Leakage Test

KAUST-B01-L05-S09 residence at King Abdullah Blvd



System

Sealing Event

Please select the ring setting matching the ring(s) installed on the fan inlet.

Test Results

	Leakage	Equivalent Hole Size (Square Inches)
	<input type="text" value="ACH50"/>	
Pre-Sealing	<input type="text" value="32.35"/>	<input type="text" value="268.9"/>
Post-Sealing	<input type="text" value="1.69"/>	<input type="text" value="14.0"/>
Improvement	<input type="text" value="30.66"/>	<input type="text" value="254.9"/>

Fanbox

Ring Setting Recommended Ring Setting: --

Fan Speed Number of Fans

Red-tube pressure (Pa)

	Current	Target
Envelope Pressure (Pa)	<input type="text" value="17.7"/>	<input type="text" value="50.0"/>
Fan Flow (CFM)	<input 320="" 685="" 865="" 905"="" data-label="Text" type="text" value="---</input></td> <td></td> </tr> </tbody> </table> </div> <div data-bbox="/> <p>Connected to Main Control Unit via Wi-Fi (3)</p>	

Menu Customer System/Sealing Preseal Seal **Postseal** Certificate

Sealed Gaps



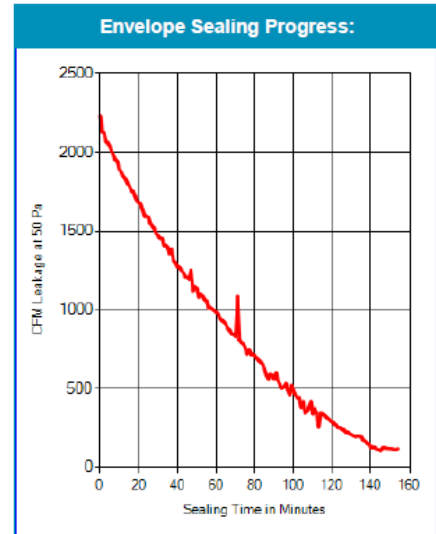


Results

- Achieved value = **2.2 ACH 50**
(Target Value \leq 3.0 ACH50)
- The building envelope was successfully sealed in **less than two months**
- 94% Improvement** in envelope tightness
- Thermal scan results were **satisfactory**

Envelope Sealing Performed For:	
KAUST-B01-L05-S09, King Abdullah University of Science and Technology King Abdullah Blvd Thuwal, Thuwal 23955	AEROBARRIER CASE ID: 8244 HARDWARE: AeroBarrier Connect
DATE: 2/22/2022	BUILDING TYPE: Apartment

Envelope Sealing Results:
BEFORE SERVICE 2233.2 CFM of Leakage, equivalent to a 268.9 Square Inch Hole, or 32.35 Air Changes per Hour <small>(for your 872 square-foot structure enclosing a volume of 4142 cubic feet)</small>
AFTER SERVICE 116.4 CFM of Leakage, equivalent to a 14.0 Square Inch Hole, or 1.69 Air Changes per Hour
This corresponds to a 94.8% Reduction in Envelope Leakage
<small>NOTE: Envelope leakage and air-change results are calculated at a standard pressure of 50 Pa.</small>



Envelope Sealing Performed By:	
 عالم المتطورة ADVANCED WORLD OF TRADING	AWT Al Malaz Riyadh, Riyadh 11227 Phone: 920002282

NOTES: a) A certified HVAC contractor or rater should be used to assess the need for enhanced/balanced mechanical equipment as the desired leakage is reduced. b) This certificate provides results based on an enclosure test, using positive pressure. A final blower door test may still be required.

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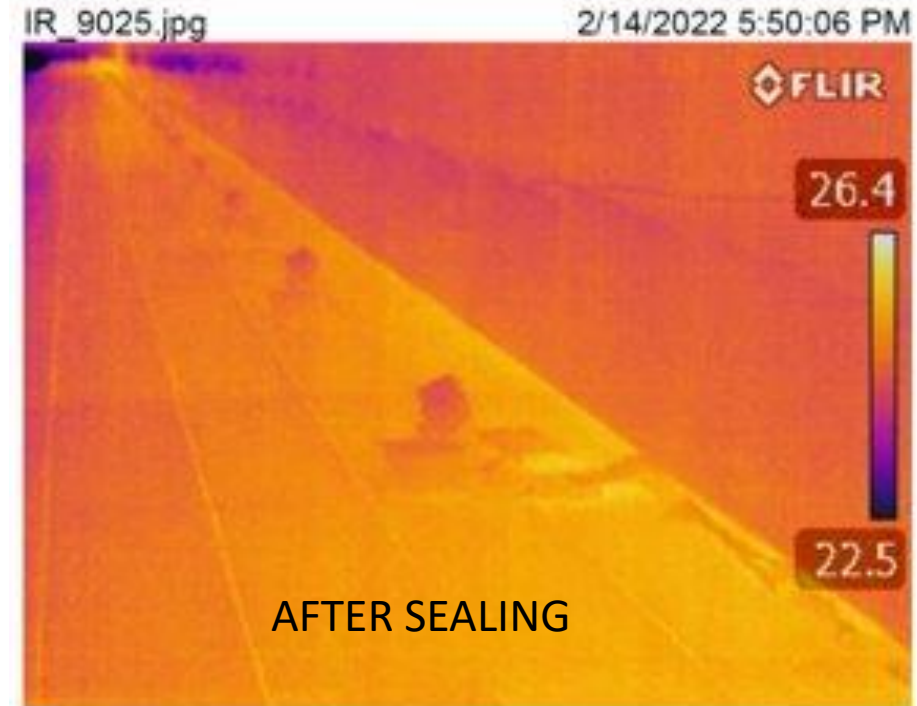
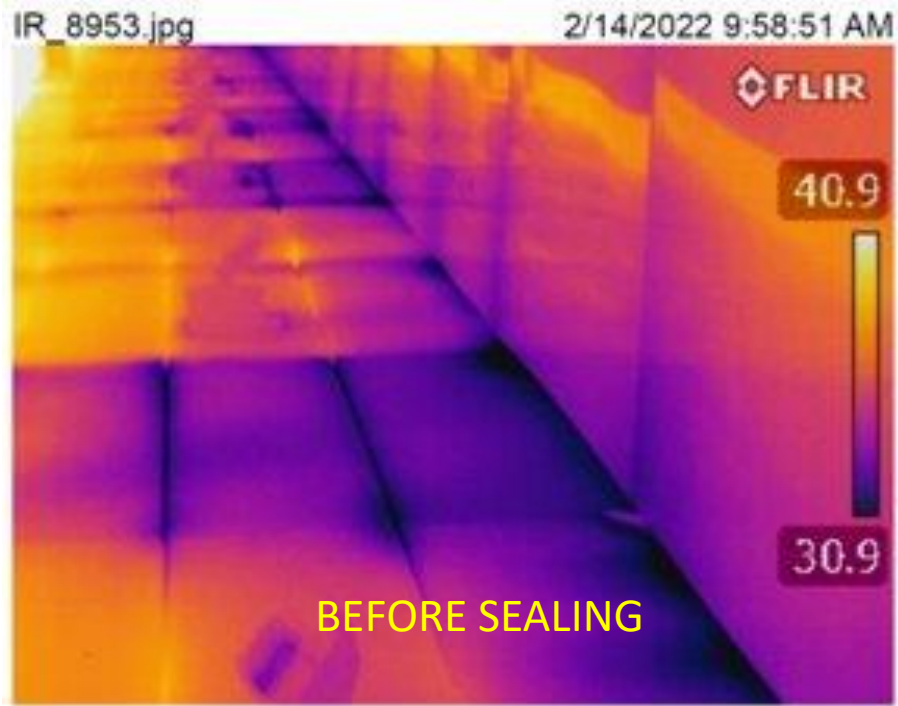


Results Summary

Sealing Job	Area sqft	Volume cu.f	Pre-ELA	Post-ELA	Pre- ACH50	Post ACH50	Pre-CFM5	Post-CFM5	Reduced CFM	Reduction %	Sealed LPS50	Sealed LPS10	Sealed LPS07
S01	2,126.00	9,265.00	637.3	49.8	34.28	2.68	5,293.40	414.00	4,879.40	92.2%	2,302.82	808.96	641.57
S02	2,128.00	8,855.00	790.3	39.7	44.48	2.24	6,564.00	330.10	6,233.90	95.0%	2,942.07	1,033.53	819.67
S03	2,604.00	10,200.00	1,031.3	26.0	50.39	1.27	8,565.50	216.30	8,349.20	97.5%	3,940.38	1,384.23	1,097.80
S04	2,704.00	11,260.00	973.2	61.7	46.43	2.73	8,083.40	512.10	7,571.30	93.7%	3,573.26	1,255.26	995.51
S05	2,467.00	10,421.00	939.9	56.1	44.95	2.68	7,806.50	466.00	7,340.50	94.0%	3,464.33	1,216.99	965.17
S06	1,641.00	6,997.00	687.3	34.3	48.95	2.44	5,708.60	284.50	5,424.10	95.0%	2,559.89	899.27	713.19
S07	2,333.00	11,727.00	948.6	59.3	40.31	2.52	7,879.00	492.10	7,386.90	93.8%	3,486.23	1,224.69	971.27
S08	1,094	2,546	322.9	14.7	63.21	2.88	2,682.10	122.10	2,560.00	95.4%	1,208.19	424.43	336.60
S09	872	4,142	268.9	14.0	32.35	1.69	2,233.20	116.40	2,116.80	94.8%	999.02	350.95	278.33
S10	1,793	54,759	813.4	93.7	7.4	0.85	6,756.00	778.50	5,977.50	88.5%	2,821.07	991.02	785.95
Total	19,762.00	130,172.00	7,413.10	449.30	41.28	2.20	61,571.70	3,732.10	57,839.60	93.9%	27,297.25	9,589.33	7,605.05



Post Sealing Observations





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Conclusion

- **94% improvement in the air tightness** – energy savings
- Sealing material was very effective in reaching and closing the **inaccessible** gaps
- Work executed **without any disruptions** to operations/ inconvenience to occupants
- **Return of Investment 1.6 years**
- Elimination of **space condensation**



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