Board of Equalization Building

450 N Street, Sacramento, CA 95814

Forensic Analysis – Glass Breakage

Prepared for DGS

Interactive Resources Project No. 2011-099-01

IDGS Contract No. 3158936 (BPM #028)

June 25, 2012

Contents

Executive Summary

Existing Conditions

450 N Street is a 24-story office building constructed in 1991 that houses the State Board of Equalization (BOE). The building is managed by the Department of General Services.

The primary exterior wall system is an aluminum-framed curtain wall consisting of insulating (double-pane) vision glass and monolithic (single-pane) spandrel glass. The vision glass consists of a tinted, heat-strengthened outer lite with a low-e coating on the No. 2 surface, a 1/2 –inch airspace, and a clear annealed inner lite.

2005 Glass Breakage and Investigation

In 2005, McGinnis Chen Associates, Inc. was retained by DGS to investigate and report on glass breakage that began in 1999 and continued through 2005. Four of the seven breakages occurred in 2005, three of them in the month of September and all four of them on the south façade. [1] Although the McGinnis Chen Associates, Inc. report is not explicit, it is our understanding that the breakage was limited to spandrel panels.

Although glass temperature can be high and varies substantially within a panel due to shading, cooling of the space behind the spandrel above ceilings and contact with thermal insulation, the McGinnis Chen Associates, Inc. report concluded that thermal stress alone was not the cause of breakage. Instead, the report concluded that thermal stress likely "…pushed some form of glass edge defect past the compression skin and caused the thermal break."

Apparently, McGinnis Chen Associates, Inc. retained Simpson Gumpertz & Heger to assist in the 2005 investigation by measuring residual surface compressive stress (RSCS) in spandrel glass panels from the building.[2]

2006 Repair

The repair design by McGinnis Chen Associates, Inc. focused on removing and examining the spandrel glass edges for defects and then replacing them. Some small number of panels was damaged and replaced as part of the repair.[3] Foam baffles were placed between the thermal insulation and the back side of spandrels at the space between the ceilings and the floors to eliminate the insulation contact. The firesafing and the portion of the batt insulation above the floor line remained in contact with the

[1] *450 N Street, Emergency Survey Investigation Report*, McGinnis Chen Associates LLP, Architects Engineers, November 15, 2005, 1

[2] Letter dated January 30, 2012, from Thomas A. Schwartz and Stephen S. Ruggiero of Simpson Gumpertz & Heger to Jaffrey Martin, AIA, of McGinnis Chen Associates, Inc.

[3] Phone conversation on May 21, 2012, between Jeff Martin and Tom Butt.

spandrel lites. All of the glass was wet sealed to address water intrusion issues unrelated to the spandrel glass failures.[4]

Apparently there were other water intrusion issues in both the walls and the plaza decks in the building, both of which were part of the 2006 repair scope.

January 2012 Spandrel Glass Break

Simpson Gumpertz & Heger

McGinnis Chen Associates, Inc. sent Simpson Gumpertz & Heger (SGH) photos and samples of the broken panel. SGH concluded that the most likely cause was NiS (Nickel Sulfide) impurity. SGH looked at projectile impact but with no information to suggest that, the likelihood was not assessed. SGH also rejected thermal stress and excessive bending.

McGinnis Chen Associates, Inc.

McGinnis Chen Associates, Inc. agreed with SGH that a Nickel Sulfide impurity was the most likely cause of the breakage and concluded that there is no feasible procedure for determining if such conditions exist in other panels. It was noted, however, that the statistical proportion of NiS failures is slightly less than 2% and that the failure rate significantly falls after 12 years.[5] The only possible mitigation suggested is the application of a safety film that would cost about $400,000 for the entire building.[6]

2012 Interactive Resources Investigation

Under DGS Contract No3158936 (BPM #38), Interactive Resources was tasked to review previous history, conduct independent investigations and provide an opinion on the cause of glass breakage.

Vision Glass

In May 0f 2012, six vision glass lites on the north side of the 18th floor were reported by tenants as "cracked." DGS replaced the lites in question and asked Interactive Resources to investigate. Wiss, Janney, Elstner, Associates, Inc., a subconsultant to Interactive Resources, determined that the reported "cracks" are, in fact, scratches that resulted from damage sustained during shipping, handling or installation. They have been in service for approximately 21 years and are not likely to sustain any related damage or failure in the future. There is no compelling justification for removal and replacement

[4] ibid
[5] The wording of the SGH letter is not entirely clear, but we believe the intent is to opine that when a NiS problem occurs, it generally affects an entire batch, and one might expect 2% of lites to fail over some unspecified time period.
[6] Letter dated January 31, 2012, from Jeffry Martin, P.E., of McGinnis Chen Associates, Inc., to Joan M. Armstrong of DGS.

of the six lites or others that have similar characteristics. If additional lites with surface defects are discovered, they can be individually examined to determine if the same prognosis is appropriate. (See Exhibit 7).

Spandrel Glass

Wiss, Janney, Elstner, Associates, Inc., a subconsultant to Interactive Resources, determined that the previously described potential causes of breakage, including mechanical damage, thermal stress, NiS inclusion and wind could very well be the cause of the January 2012 breakage, none can be confirmed based on the evidence, and none appears to be more likely than another.

Conclusions and Mitigations

While applying a safety film or replacing the spandrel lites with new laminated glass may not reduce the chance of future breakage, both will mitigate the risk of post breakage fall out. Both also have significant costs and potential downside consequences.

The risk of future breakage of the existing glass is both low and consistent with risks in typical buildings of the same age and design. The only way to eliminate fallout risk would be to replace the glass with laminated glass or apply a safety film. (See Exhibit 8).

Externally applied safety film has a limited lifetime applied to the exterior and a limited warranty period, if available at all. Application to the interior would be tedious, expensive and intrusive.

Replacement with new glass would also be expensive and may still result in some rate of breakage, which could be mitigated by using laminated glass or glass with a safety film pre-applied to the back side.

Introduction

1991 Original Construction

The building at 450 N Street was constructed in 1991. Key participants included:[7]

- Architect: Dreyfus Blackford Architects
- Curtain Wall Consultant: Eschbach Company, Inc.
- General Contractor: Hensel Phelps Construction Co.
- Glazing Subcontractor: Architectural Glass & Aluminum (AG&A)
- Curtain Wall Manufacturer: Kawneer
- Glass Supplier: Tempglass Eastern, Inc.

[7] *450 N Street, Emergency Survey Investigation Report*, McGinnis Chen Associates LLP, Architects Engineers, November 15, 2005, 1

Existing Conditions

The building curtain wall system is a Kawneer 1600 series. There is a gold-colored aluminum trim piece that sits outboard of the spandrel panels and spans between mullions. The vision glass is a double pane Insulated Glass Unit (IGU), and the spandrels are single pane heat strengthened glass with a ceramic frit on the backside.[8,9]

2005 Investigation

In 2005, McGinnis Chen Associates, Inc. was retained by DGS to investigate and report on glass breakage that began in 1999 and continued through 2005. Four of the seven breakages occurred in 2005, three of them in the month of September and all four of them on the south façade. [10] Although the McGinnis Chen Associates, Inc. report is not explicit, it is our understanding that the breakage was limited to spandrel panels.

Although glass temperature can be high and varies substantially within a panel due to shading, cooling of the space behind the spandrel above ceilings and contact with thermal insulation, the McGinnis Chen Associates, Inc. report concluded that thermal stress alone was not the cause of breakage. Instead, the report concluded that thermal stress likely "…pushed some form of glass edge defect past the compression skin and caused the thermal break."

Apparently, McGinnis Chen retained Simpson Gumpertz & Heger to assist in the 2005 investigation by measuring residual surface compressive stress (RSCS) in spandrel glass panels from the building.[11]

2006 Repair

The repair design by McGinnis Chen Associates, Inc. focused on removing examining the spandrel glass edges for defects and then replacing them. Some small number of panels was damaged and replaced as part of the repair.[12] Foam baffles were placed between the thermal insulation and the back side of spandrels at the space between the ceilings and the floors to eliminate the insulation contact. All of the glass was wet sealed to address water intrusion issues unrelated to the spandrel glass failures.[13]

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[8] *450 N Street, Emergency Survey Investigation Report*, McGinnis Chen Associates LLP, Architects Engineers, November 15, 2005, 2

[9] While not relevant to the future of the building, it is interesting in hindsight that the Architect's original spec appears to have been to use laminated glass for the spandrels, which would have mitigated all the fallout issues. Somewhere along the construction process it must've been value engineered to monolithic glass.

[10] *450 N Street, Emergency Survey Investigation Report*, McGinnis Chen Associates LLP, Architects Engineers, November 15, 2005, 1

[11] Letter dated January 30, 2012, from Thomas A. Schwartz and Stephen S. Ruggiero of Simpson Gumpertz & Heger to Jaffrey Martin, AIA, of McGinnis Chen Associates, Inc.

[12] Phone conversation on May 21, 2012, between Jeff Martin and Tom Butt.

[13] ibid

Apparently there were other water intrusion issues in both the walls and the plaza decks in the building, both of which were part of the 2006 repair scope.

January 2012 Spandrel Break

Simpson Gumpertz & Heger

McGinnis Chen Associates, Inc. sent Simpson Gumpertz & Heger (SGH) photos and samples of the broken panel. SGH concluded that the most likely cause was NiS (Nickel Sulfide) impurity. SGH looked at projectile impact but with no information to suggest that, the likelihood was not assessed. SGH also rejected thermal stress and excessive bending.

McGinnis Chen Associates, Inc.

McGinnis Chen Associates, Inc. agreed with SGH that a Nickel Sulfide impurity was the most likely cause of the breakage and concluded that there is no feasible procedure for determining if such conditions exist in other panels. It was noted, however, that the statistical proportion of NiS failures is slightly less than 2% and that the failure rate significantly falls after 12 years. The only possible mitigation suggested is the application of a safety film that would cost about $400,000 for the entire building.[14]

2012 Interactive Resources Investigation

Assignment and Scope of Services

Under DGS Contract No3158936 (BPM #38), Interactive Resources was tasked to provide:

> …a second opinion as to the cause of the spontaneous spandrel glass break last month, as well as recommendations to remediation of the problem.[15]

Specifically, the Scope of Services included the following:[16]

> Contractor shall provide labor, equipment and materials required to conduct a thorough forensic investigation as to cause of incident on Wednesday, January 11, 2011, at 10:30 a.m. in the morning when spandrel glass window pane between the 8th and 9th floors broke spontaneously and fell onto the sidewalk below the Board of Equalization Building (028) located at 450 N Street, Sacramento, CA 95814.
>
> Contractor shall provide the following services:

[14] Letter dated January 31, 2012, from Jeffry Martin, P.E., of McGinnis Chen Associates, Inc., to Joan M. Armstrong of DGS.
[15] Letter dated February 12, 2012 from Cindy Kawano to Tom Butt
[16] Agreement dated April 9, 2012, between State of California Department of General Services, Real Estate Division, and Interactive Resources, Inc.

1. Project management – to include planning, oversight, coordination, scope development and logistics.
2. Review available project documents and reports – original construction, shop drawings, submittals, reports and repair documents.
3. On-site visits and inspections – observe the recently broken lie and document the breakage pattern/conditions and framing conditions, original construction and glazing (if any exists) and 2006 repair construction and glazing.
4. Testing – participate in façade drops and surface compressive strength stress (pre-stress of the heat-strengthened glass) at the broken lie and selected other locations. Laboratory testing.
5. Subcontractor to rig and operate swing stage for exterior access to the inspection area(s).
6. Peer reviews – as needed.
7. Report – written report (three copies) of findings and recommendations for mitigation measures, further investigation and alternative materials.
8. Meetings – attend start-up and follow-up meetings with the State, as needed.

Scope Expansion

On May 8, Lisa Lambeth requested that the investigation scope be expanded to cover the scratched vision lites.

Project Team and DGS Project Manager

Interactive Resources assembled a team for the project that included:

Building Manager and DGS Contact

Lisa Lambeth, Building Manager
Ben Ruedger, Access Manager
1616 Capitol Avenue, Suite 74.149
Sacramento, CA. 95814
Phone (916) 445-1076
Cell (916) 869-1702
Fax (916) 445-1077
Lisa.Lambeth@dgs.ca.gov

Project Manager
Tom Butt, FAIA, LEED BD+C
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Architects and Engineers
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Glazing Consultant
David Green, AIA
Senior Associate
Wiss, Janney, Elstner Associates, Inc.
Engineers | Architects | Materials Scientists
2000 Powell Street, Emeryville, CA 94608
tel 510.428.2907
direct 510.450.5540
fax 510.428.0456
www.wje.com
dgreen@wje.com

Swing Stage Contractor
Jim Stine
4 Wayne Court Building #9
Sacramento, CA 95829
Phone: (916) 379-0010
Fax: (916) 379-0030
jim.stine@fdthomas.com

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2750 Redding Avenue
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916/364-3600
pbol@bagatelos.com
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Peer Reviewer
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Engineering Consultant
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Rockwall, Texas 75087
Phone: (972) 771-1600
Fax: (972) 771-0354
Cell: (972) 567-2484
E-mail: lingnell@swbell.net

Field Work

On May 2, 2012, Andy Weber of WJE went to Sacramento to observe vision lite replacement that failed to occur. Tom Butt was en route but turned around when it was determined the replacement would not occur.

Tom Butt and David Green spent the day of May 8, 2012, at the site observing:

- Remains of the broken lite that was removed in January 0f 2012.
- The location of the January 2012 break.
- Locations of reported vision glass cracks on the 18rd floor.

On May 18, 2012, David Green of WJE observed the removal of the reportedly cracked lites.

Documents Reviewed

- Section 08800, Glass and Glazing, Capital Square Specifications, November 5, 1990, Dreyfuss & Blackford, Architects
- *450 N Street, Emergency Survey Investigation Report*, McGinnis Chen Associates LLP, Architects Engineers, November 15, 2005
- Drawings, 450 N Street Curtainwall and Balcony Remediation, April 19, 2006, (JR Roberts As-Builts), McGinnis Chen Associates, Inc.
- Specification Section 08800, Curtain Wall and Balcony Remediation, March 16, 2006, McGinnis Chen Associates, Inc.
- Letter dated January 30, 2012, from Thomas A. Schwartz and Stephen S. Ruggiero of Simpson Gumpertz & Heger to Jeffrey Martin, AIA, of McGinnis Chen Associates, Inc.
- Letter dated January 31, 2012, from Jeffry Martin, P.E., of McGinnis Chen Associates, Inc., to Joan M. Armstrong of DGS.

Documents requested but unavailable include the remainder of the design and construction files form the 2005 investigation and 2006 repair.

Photos

All annotated photos are included in the Exhibits. Selected photos appear in the text.

Vision Lite Investigation by Interactive Resources

Interactive Resources retained Wiss, Janney, Elstner Associates, Inc., to assist in the investigation of reported vision lite abnormalities. David Green, AIA, conducted the field work and prepared the report in Exhibit 7.

In our opinion, the abnormalities that were originally reported as fractures are, in fact, surface scratches, some of which date from the time of the original fabrication, and some of which may have occurred during shipping, handling or installation. The scratches do not pose a safety threat and do not provide a compelling justification for replacement.

> The scratches observed on the lites in question were all on the surface of the glass, and were not cracks through the body of the glass. All the lites except Lite #4 have scratches which continue beyond the edge of the normally exposed area of the lite, indicating that the scratches occurred during or prior to installation. At the lites that were removed, the scratches correlate with areas of edge damage. It appears that the scratches and edge damage (chips) were caused by the same event during shipping, handling, or installation. These lites with scratches have been in service for 21 years, without any incidents of breakage of the inner lites of the vision glass units. We are not aware of any reports of broken inner lites of vision glass in the history of the building.
>
> We offer the following comments regarding the influence of the observed scratches on the likelihood of future breakage:
>
> Thermal Stress Breakage. The presence of flaws, particularly edge flaws, makes glass more susceptible to thermal stress breakage. However, systemic thermal stress breakage problems typically manifest themselves within 2 to 3 years of installation, as the building experiences a range of temperature conditions. Having now undergone more than 20 years of thermal cycling, it is likely that future temperature conditions will be no more adverse than those already experienced, making future thermal stress breakage unlikely at this point.
>
> Wind Load Breakage. Any given lite of glass on the building may not yet have experienced its full design wind load during its life thus far. However, we have calculated the design wind load on the glass per the current California Building Code, and have determined by calculation per ASTM E1300 that the heat-strengthened outer lite alone is sufficient to withstand the design wind load. Even if one of the inner lites were to break, the risk of a subsequent breakage of the outer lite is low. Furthermore, visible flaws, such as the documented scratches, do not necessarily limit the ability of the glass to resist wind loads, especially if these flaws occur outside of the high stress regions of the glass (which is the case for Lite #1 through #3 and Lite #5).
>
> Finally, with either breakage scenario, the lites in question are the inner lite of the IGU and they are made of annealed glass. Therefore, in the unlikely event they were to break, they would not pose a safety threat to passers-by below and the crack pattern would be such that the glass fragments would likely stay in the opening.
>
> Based on the successful service history and minimal risks going forward, in general we do not believe there is a compelling justification for the removal and replacement of these six lites. If additional lites with surface or edge damage are brought to DGS's attention, WJE is available to review them to determine if a similar prognosis is appropriate.[17]

[17] Letter dated May 31, 2012, from David Green to Tom Butt (Exhibit 7)

Spandrel Panel Investigation by Interactive Resources

Interactive Resources retained Wiss, Janney, Elstner Associates, Inc., to assist in the investigation of reported vision lite abnormalities. David Green, AIA, conducted the field work and prepared the report in Exhibit 8.

Wiss, Janney, Elstner, Associates, Inc., a subconsultant to Interactive Resources, determined that the previously described potential causes of breakage, including mechanical damage, thermal stress, NiS inclusion and wind are all potential causes of the January 2012 breakage, but none can be confirmed based on the evidence, and none appears to be more likely than another.

While applying a safety film or replacing the spandrel lites with new laminated glass may not reduce the chance of future breakage, both will mitigate the risk of post breakage fall out. Both also have significant costs and potential downside consequences.

The risk of future breakage of the existing glass is both low and consistent with risks in typical buildings of the same age and design. The only way to eliminate fallout risk would be to replace the glass with laminated glass or apply a safety film. (See Exhibit 8).

Externally applied safety film has a limited lifetime applied to the exterior and a limited warranty period, if a warranty is even available. Application to the interior would be tedious, expensive and intrusive.

Replacement with new glass would also be expensive and may result in some rate of breakage, which could be mitigated by using laminated glass or glass with a safety film pre-applied to the back side.

> Considering the limited number of breaks overall, and the long duration between this recent break and the previous occurrences, at this time there does not appear to be a systemic breakage problem. Given the age of the original and replacement glass, the time period during which thermal stress or NiS-related failures might typically be anticipated has passed. While there can be no guarantee that future breakage will not occur, in our opinion, the risk of future breakage is more or less the same as the breakage risk in any other high-rise building of similar age with heat strengthened spandrel glass. Consequently, no extensive mitigation measures are necessary if ownership accepts the risks common to similar heat strengthened spandrel glass in similar vintage high-rise curtain walls.
>
> If the above-described risk is acceptable to DGS, as an additional precaution, they might consider monitoring the spandrel glass for a period of time. A monitoring program might consist of a binocular survey on a regular schedule of decreasing frequency.
>
> The only way to preclude future spandrel glass fallout is to replace the glass with laminated or safety-filmed lites or to apply a safety film to the existing lites. As stated above, with any

replacement scenario, some breakage will likely occur, but with lamination or film application, fallout risk would be virtually eliminated.[18]

Peer Review

Peer reviewer Bill Lingnell had no comments that would change the conclusions of the report. His comments included the following:

- It is unfortunate that clear evidence of the points of origin of any of the breaks was not preserved and available for detailed evaluation. For this reason, none of the investigations was able to identify a point of fracture origin and therefore a clear cause of breakage. If future breakage occurs, an effort should be made to identify and preserve the fracture origin area for further examination. Lingnell provided a detailed protocol for preserving evidence of the initial break location. This information should be made available to building management staff and referenced in the case of any future breakage.
- Lingnell provided an additional detailed description of breakage from nickel sulfide inclusions.
- Lingnell had additional comments about the use of laminated glass or safety film as a mitigation and noted that safety film would preserve the fracture origin.

The peer review documents are in Exhibit 10.

Preparation and Limitations

Limitations

The services of Interactive Resources are provided in a manner we believe to be consistent with the prevailing standard of care. This report is neither comprehensive nor exhaustive and is based on limited observations of the project, limited exploratory demolition, review of documents cited and discussions with individuals listed. The information is for the exclusive use of the client to whom this is addressed.

Interactive Resources does not warrant or guarantee the performance of any in-place or future construction on this project, whether or not it incorporates any of the recommendations contained herein.

Preparation

This report was prepared by Thomas K. Butt, FAIA, LEED BP+C with assistance from David Green, AIA, and peer review by William Lingnell.

[18] Letter dated May 31, 2012, from David Green to Tom Butt (Exhibit 8)

Licensed Architect California C7389
Licensed General Contractor California 290922

Exhibit 1 – Section 08800, Glass and Glazing, Capital Square Specifications, November 5, 1991, Dreyfuss & Blackford, Architects

CAPITOL SQUARE

SPECIFICATIONS

87178.07

NOVEMBER 5, 1990

DREYFUSS & BLACKFORD ARCHITECTS
3540 Folsom Boulevard
Sacramento, California 95816

SECTION 08800

GLASS AND GLAZING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Provide all labor, materials, tools, services and installation of the following:

1. Glass, glazing and setting materials.
2. Sloped glazing.
3. Miscellaneous glass specialty items including, but not necessarily limited to, the following:
   a. Large size custom mirrors.

1.02 SUBMITTALS

A. Manufacturer's literature describing glass and glazing materials as per requirements of Section 01300.

B. Samples: Samples of each type of glass except clear single panel units.

C. Shop Drawings: Show full size details of glazing methods.

D. Thermal Stress Analysis for tinted glass if required by Paragraph 3.03.B.4.

E. Manufacturers' recommended maintenance and cleaning procedures.

1.03 QUALITY ASSURANCE

A. Standards:

1. American Society for Testing and Materials (ASTM).
2. Federal Specifications (FS).
3. Flat Glass Marketing Association's "Glazing Manual", (FGMA).
4. American National Standards Institute's "Performance Specifications and Methods of Test for Transparent Safety Glazing Material Used in Buildings" (ANSI Z97.1-1975).
5. Uniform Building Code, 1988 Edition (UBC).
6. Title 24, California Administrative Code (CAC).

B. General Requirements: All glass and glazing shall meet requirements of UBC Chapter 54.

PART 2 - PRODUCTS

2.01 GLASS PRODUCTS

A. General Requirements:

1. Glass products shall conform to ASTM C1036 and C1048.
2. Tempered and laminated glass shall meet ANSI Z97.1-1975 requirements.
3. No tong marks shall be permitted, and any expected markings and/or distortions shall be made known and presented to the Architect prior to processing.

B. Glass Thicknesses: Glass thicknesses shall be as noted unless glass manufacturer recommends greater to meet wind load requirements.

C. Glass Types:

1. Glass "A": Gray 1/4 VE3-80 (#2) (outside) x 1/2 AS x 1/4 CL (inside) Viracon, Cardinal or approved equal. Outside light to be heat strengthened.

2. Glass "B": (Spandrel) Gray 9/16 OA VE 3-80 HS (#2) x .060 PVB x 1/4 CL with custom colored 4 Viracon, Cardinal or approved equal. Light to be heat strengthened.

3. Glass "C": Tempered clear float glass, ASTM C1036, Type I, Class 1, Quality q3, 3/8 inch thick as manufactured by PPG, Ford Glass, (LOF) Libbey-Owens, Ford Company or approved equal (First Floor glazing below 10 feet).

4. Glass "D": Tempered clear float glass, ASTM C1036, Type I, Class 1, Quality q3, 1/2 inch thick as manufactured by PPG, Ford Glass, (LOF) Libbey-Owens-Ford Company or approved equal (automatic entry doors).

5. Glass "E": Sloped glazing (Atrium) Gray 1/4 VE3-80 (#2) x 1/2 AS x 9/16 CL Viracon, Cardinal or approved equal. Outside light to be tempered and inside light to be laminated.

6. Glass "F": Clear wire glass, ASTM C1036, Type II, Class 1, Form 1, Quality q8, Mesh M1 (diamond).

2. Standards for Installation: Comply with the applicable requirements of the "Glazing Manual" of the Flat Glass Marketing Association, except as may otherwise be shown or specified, and except as may be specifically recommended by the manufacturer of the glass or glazing material.
3. Inspection of Materials: Immediately prior to installation of glass, inspect all edges for flares, chips or irregularities, and faces for scratches or surface disfigurements. Materials with such blemishes shall be rejected and not installed on this Project.
4. Appearance: Unify appearance of each series of lights of glass by setting each piece to match those adjacent, as nearly as possible. Inspect each piece and set with the pattern, draw and bow oriented in the same direction as those adjacent.
5. Clean all members to receive glass, immediately prior to installation of the glass.
6. Cut and set glass to full fit and play consistent with expansion and contraction requirements and for absolute security under maximum high velocity wind or vacuum stresses.

B. Tinted Glass:

1. Take special care to create strong undamaged edges.
2. Cut glass on northerly elevations according to standard clear glass practice.
3. Ensure glass on sunny elevations has clean-cut edges without deep shark teeth, flake chipping, impact damage, convolutions, or serration hackle and spalling.
4. A thermal stress analysis is required from the manufacturer where one or more of the following conditions occur:
   a. Edge area equal to or exceeding 200 square inches.
   b. Indoor Shading: Glass shade space less than six inches or non-vented.
   c. Indoor heat source between glass and shade.
   d. Outdoor shading with double diagonal shade lines meeting at head, jamb, or sill.
   e. When glass is thicker than 1/4 inch and glazing rabbet is concrete or other material with large heat capacity.
   f. Pattern cuts with notches or holes.
   g. Pattern cuts when glass is thicker than 1/4 inch.

SECTION 08920

GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.01 DEFINITIONS

A. The term "Glazed Aluminum Curtain Walls", hereinafter referred to as "System", includes all exterior curtain wall, window wall, sloped glazing, and entrance systems.

B. The term "Contractor" is that entity charged with absolute and total responsibility for the work described in this specification.

1.02 SUMMARY OF WORK INCLUDED

Furnish all labor, materials, equipment and services necessary to provide the System as shown and specified, installed complete.

A. Items furnished and installed:

1. Extruded aluminum framing members.
2. Glass, gaskets, setting and edge blocks.
3. Aluminum covers, glazing channels, beads, trim, aluminum brake shapes, and similar accessories indicated as integral components of the System.
4. Anchorage of the framing members to the structure, including all clips, brackets and fasteners required to do so.
5. Internal structural reinforcing in mullions, transoms, doors and other components as required to comply with the structural requirements hereinafter specified.
6. Adapters for interior drywall.
7. All sealants and backer rods within the System and those between adjoining work and the System.
8. All flashings related to the System.
9. Insulation in the System spandrel areas as well as between mullions, building columns and/or partitions.
10. Firesafing insulation in relation to the System.
11. Alterations to the System as necessary to accommodate and close up the hoist opening(s).
12. Laboratory and site testing as specified.
13. Specified submittals and warranties.
14. Protection and cleaning.
15. Visual site mock-up for glass and aluminum.

B. Items furnished but not installed:

Rubber Products.

11. E 283 - Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors.
12. E 330 - Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
13. E 331 - Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.

E. Aluminum Association (AA):

1. Aluminum Standards and Data.
2. Specifications for Aluminum Structures.

F. American Institute of Steel Construction (AISC):

1. Cold-Formed Steel Design Manual.
2. Manual for Steel Construction.

G. General Services Administration (GSA):

1. HH-I-521E - Insulation Blankets, Thermal.
2. FS TT-P-645 for Prime Paint.

H. American National Standards Institute (ANSI):

1. Z97.1 - Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings.

I. U.S. Consumer Product Safety Commission:

1. Document 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.

J. Flat Glass Marketing Association (FGMA):

1. Glazing Manual.
2. Sealant Manual.

K. American Welding Society (AWS):

1. D1.1 - Structural Welding Code.

1.04 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor is hereby advised that the responsibility for the System is totally his and that all designs and resolutions proposed in the shop drawings, calculations and related documentation and certification must be demonstrated, not only in the test procedure but also throughout the warranty periods herein specified. No compensation for omissions and errors on the part of the Contractor in the execution of this contract will be awarded.

1.06 SYSTEM DESIGN CRITERIA

A. The System shall be weathertight, structurally sound, self-draining and will allow no water infiltration (infiltration is defined as the appearance of uncontrolled water other than condensation on the indoor face of any portion of the System).

B. The details shown indicate the preferred profiles and dimensions to achieve the design concept. Dimension and profile adjustments to those shown may be made, provided that the visual design concept and intent of the specifications are maintained.

C. All components, assemblies and completed work shall conform to the following performance criteria and comply with the applicable codes of governing agencies, and with the wind pressure study prepared by RWDI, dated June 11, 1990, Report #90-185-03. Copies will be made available through the General Contractor. Except when applicable codes make other provisions, or as noted herein, loads shall act in combinations that provide the most unfavorable conditions. Wind loading need not be considered as additive to seismic loading.

D. System shall be designed for flexural, shear and torsional stresses resulting from positive and negative wind pressures as shown on the wind pressure diagrams on the architectural drawings.

E. Maximum permissible deflections and stresses shall be:

1. Normal to the plane of the wall, deflection of framing members at design pressure shall not exceed 1/175 of span length or 3/4-inch, whichever is less, except that when a plastered surface subjected to bending is affected, the deflection shall not exceed 1/360 of span.
2. In the plane of the wall, deflection of framing members when carrying their full design deadload shall not reduce the glass or panel bite below 75% of the design dimension, and shall not reduce the glass or panel edge clearance below 25% of the design dimension or 1/8-inch, whichever is greater. Restrict deflection further if required for proper assembly and fit of components.
3. At connection points of framing members to anchors, anchor deflection in any direction shall not exceed 1/16-inch.
4. Stresses must take into account interaction and shall not exceed the allowable values established by the specifications listed under References. In no case shall allowable values exceed the yield stress.
5. At 1-1/2 times design pressure, permanent deflections of framing members must not exceed 1/1000 of span length, and components must not experience failure or gross permanent distortion. At connection points of framing members to anchors, anchor deflection in any direction shall not exceed 1/8-inch and permanent set shall not exceed 1/16-inch.

contact, such as spacers, setting blocks, gaskets and sealed edges of insulating glass units.

1.07 MATERIAL AND ASSEMBLY TESTS

A. A performance mock-up shall be constructed and tested at an approved, accredited independent laboratory.

B. The configuration of the test unit shall be as shown on the architectural drawings and be representative of the actual building conditions, including corners, and is subject to approval of the Owner and Architect. Mock-up shall contain actual materials as furnished for the projet and be suitable for visual examination of materials by the Architect.

C. Contractor shall be the coordinator of the installation of all components of the test unit, including those materials which may be furnished and installed by another trade.

D. Test results (to be substantiated by a certified report) shall meet or exceed the following:

1. Air infiltration, when tested in accordance with ASTM E-283, must not exceed:
   a) .04 cfm/ft of wall area at 1.57 psf pressure;
   b) .06 cfm/ft of wall area at 6.00 psf pressure.
2. No water infiltration will be allowed during the tests listed below:
   a) static test per ASTM E-331 at 10.00 psf pressure differential;
   b) dynamic test per AAMA 501.1 at 10.00 psf pressure differential.
3. Deflections, deformation and stresses must be within the limits established in Paragraph 1.06.E when the structural tests listed below are conducted per ASTM E-330. Gauges shall be set to zero prior to each application of pressure.
   a) test at design pressure, +50 psf and -55 psf;
   b) test at 150% of design pressure, +75 psf and 82.5 psf.
4. The seismic tests listed below are to consist of displacement of the System in a horizontal direction parallel and perpendicular to the plane of the glass, in both directions, held for 10 seconds in each of the displaced positions, and returned to the original position. Three 2-stroke cycles are required for each test. The results must comply with Paragraph 1.06.F:
   a) test at probable displacement of 0.91".
   b) test at maximum displacement of 1.81".
5. Perform concentrated load tests on window washing equipment restraints as follows:
   a) apply 600 lbs. outward for at least ten seconds;
   b) apply 250 lbs. side load in each of the four directions parallel to glass, for at least ten seconds;
   c) there shall be no failure, gross permanent distortion,

layout of all adjacent walls, beams, columns and slabs, all correctly dimensioned to each other and grid lines. Dimension position of glass edge relative to metal daylight.

2. In addition to the above requirements, submit the following schedules and instructions:
   a) Schedule of all sealants, primers, back-up materials, tapes, gaskets, separators and related items including the location where each material is to be used, methods of application, special instructions, cross-references to the shop drawings, and explanatory details as required to insure and appraise the complete application of all sealants.
   b) Detailed instruction for the installation and reglazing of glass units including explanatory details indicating the sequence of installation, method of installation for all materials, location of specific items and any special instructions as may be required.

C. Prepare and submit (with shop drawings) structural calculations for all work of this Section, including mock-up. Comply with current design rules of the Aluminum Association, AISC, AISI and ACI. Include analysis for wind, dead load and seismic load on framing members and anchors. Show Section property computations for framing members.

1. Existing test reports shall not be an acceptable substitute for calculations.
2. In no case shall glass be considered as a lateral brace for framing members.
3. Anchor clips with slotted holes shall be calculated in the most extended conditions.
4. Calculations shall dimensionally limit the stacking of shims in regard to bending stresses in bolts, clips, etc.
5. Calculations shall be signed and sealed by a registered licensed structural engineer in the State of California.

D. Provide written certification that the following materials conform to the specifications:

1. Aluminum alloys and finishes.
2. Steel alloys and finishes.
3. Sealants.
4. Glass.
5. Glazing materials.
6. Fasteners.
7. Insulation and firesafing.

E. Submit a detailed diagram to the glass manufacturer indicating how his product will be used in the System, as well as written information describing application and/or installation techniques, wind load, wall and building movement, magnitude of thermal expansion, blocking and sealing and any other procedures, operations or exposures which may affect the performance of his product. Glass

1.09 PRODUCT HANDLING

A. Package and store materials in a manner that will prevent surface damage or contamination, distortion, breakage or structural weakening.

B. Replace any materials damaged during manufacture, shipping, storage or erection.

C. Protect materials in place from contamination and damage.

1.10 WARRANTY

A. Any warranty specified in other sections of the contract specifications notwithstanding, the Contractor will be required to furnish a written 5-year warranty, effective from the date of substantial completion, the intent of which is to provide the Owner with a quality, watertight System installation during that period.

B. Under the terms of this warranty, the Contractor agrees to repair or replace defective materials, workmanship or failures, in a timely, satisfactory manner, at no cost to the Owner.

C. Any items which are normally warranted for a time period which exceeds the required warranty shall be provided with the extended warranty.

D. Any items which do not carry the specified warranty, and any qualifications which may adversely affect the warranty, must be presented prior to award of contract for review and approval by the Architect and Owner. Failure to follow this procedure constitutes tacit acceptance that all components of the System installation will be included in the specified warranty.

PART 2 - PRODUCTS

2.01 SYSTEM

A. The exterior wall system shall be provided in accordance with the Architect's approved drawings.

B. System proposed by the Contractor must be equal to or better in design, performance and material standards than as described on the Architect's drawings and in this specification.

C. System profiles shall be as shown on the architectural drawings.

D. Acceptable manufacturers are as follows:

1. Kawneer - 2500 IB (I-Beam) and 1600 IG System. 2-1/2 by 6-1/4 inches.
2. Vistawall - CW 400 Curtain Wall System. 2-1/2 by 5-1/2

Other properties shall be as specified for silicone gaskets.

c) Setting blocks and setting block chairs shall be secured against migration.

4. Edge blocks:
   a) Provide edge blocks to limit lateral movement of each lite. Blocks shall be 65+/-5 durometer shore A solid neoprene.
   b) Edge blocks are not required where an individual glass lite is continuously sealed with silicone at its two vertical edges.
5. Setting and edge blocks are to be sized and located in accordance with FGMA Glazing Manual.

D. Sealants

1. General sealant requirements:
   a) Locate and identify all sealants by product name on shop drawings.
   b) All sealant shall be tooled as a separate operation after application, to fill joints and provide a smooth surface.
   c) In using specified sealants or approved alternates, strictly observe the printed instructions of the sealant manufacturer regarding joint size limitations, mixing, priming and application. Where printed instructions are indefinite on the use of a primer, consult sealant manufacturer. Unless printed instructions advise to the contrary, do not apply sealants when substrates are wet or when the temperature is below 40oF.
   d. Sealant back-up material shall be polyethylene foam, sponge neoprene conforming to ASTM C509, or urethane foam as recommended by sealant manufacturer.
   e. Color of sealant to be selected by the Architect.
2. Shop and field sealants:
   a) Acceptable materials for shop or field application of structural sealants are silicones as manufactured by Dow Corning, G.E. or Tremco.
   b) Acceptable materials for nonstructural shop or field application as part of the assembly and installation procedure are silicones and polyurethanes as manufactured by Dow Corning, G.E., Tremco or Mameco.
   c) Alternate sealant materials will be considered if technical data sheets and cured and uncured samples are submitted. However, polybutene, oleoresinous, asphaltic, and other oil base sealants are not acceptable for field use.

E. Miscellaneous materials

1. Fasteners:
   a) Type, size, alloy, quantity and spacing of all fasteners and anchorage devices shall be as required for

performance.

b) All screws, bolts, nuts, washers and rivets in wetting locations shall be 300 series nonmagnetic stainless steel. Fasteners in non-wetting locations can be cadmium plated or an approved equal.

c) Exposed fasteners will be permitted only where approved by the Architect and shall be stainless steel with countersunk oval head, Phillips drive, finished to match adjacent finish.

d) All anchor bolts and nuts shall have self-locking devices incorporating nylon inserts or patches similar to those manufactured by USM Corporation, Nylock Fastener Division.

2. Steel:

a) Hot-rolled shapes and plate shall comply with ASTM A36.

b) Cold-formed steel shall conform to one of the material specifications listed in the "Specification for the Design of Cold-Formed Steel Structural Members".

c) All steel plates and shapes shall be prime painted, hot dipped galvanized or electro-galvanized. Any damage to protective coatings shall be touched up in the field with an appropriate coating.

3. Inserts for anchorage in concrete shall be steel with integral or welded projections for embedment and finished to provide maximum adhesion to concrete.

4. Weep hole baffles shall be 45 pore per inch open cell plastic coated urethane foam, compressed 30%-50%.

5. Slip pads:
Provide eel slip, nylatron, high impact polystyrene or approved equal slip pads between moving parts at all dynamic connections. Provide minimum thickness of 1/16" for nylatron and polystyrene, and 1/8" for eel slip. Do not use nylatron or polystyrene in close proximity to a field weld.

6. Flashings:
Flashings in direct relationship with the aluminum framing system shall be of aluminum. Exposed flashings shall have hemmed edges where exposed to view to provide stiffness and a retainer for splice sleeves, and shall be finished in accordance with the aluminum framing system specification 2.03.

★ Addm.#2 7. Insulation:
Insulate ~~spandrel areas~~ with USG Thermafiber foil-faced insulation. Follow glass manufacturer's recommendation for air space requirements.

~~8.~~ Safing insulation:

~~a) Pack void between slab edge and curtain wall with USG Thermafiber safing insulation or an approved equal. Thickness shall be 4" minimum and density shall be 4 PCF.~~

~~b) Support fire stop insulation on galvanized steel brackets spaced at a maximum of 24" on center. Reduce spacing as needed to assure positive retention of insulation.~~

A. Insofar as practicable, fitting and assembly of the work shall be done in a shop.

B. All exposed work shall be carefully matched to produce continuity of line and design. All joints in exposed metal work, unless otherwise shown or specified, shall be accurately fitted and rigidly secured with joint sizes conforming to industry standards.

C. The method of assembly and joining shall be the Contractor's option provided the results are satisfactory. Distortion of metal work or fasteners overstressed from expansion and contraction of the metal will not be acceptable.

D. All welding shall be in accordance with the recommendations of the American Welding Society, with electrodes and/or by methods recommended by the manufacturer of the alloys being welded. Distortion or discoloration of exposed metal surfaces caused by welding will not be acceptable. All weld spatter and welding oxides on finished surfaces shall be removed by descaling and/or grinding.

E. All weld beads on exposed surfaces shall be ground and finished to match and blend with finish on adjacent parent metal. Grinding and polishing of nonferrous metal shall be done only with clean wheels and compounds free from iron compounds. No soldering and/or brazing shall be allowed.

F. Conceal fasteners.

G. Correct any errors, omissions or inconsistencies before proceeding. Promptly furnish items to be placed during the installation of other work.

PART 3 - EXECUTION

3.01 ERECTION

A. Erect material in accordance with the approved drawings. Provide labor, material, booms, accessories and supervision necessary to erect the System. Set plumb, square and level and fasten securely in correct vertical and horizontal alignment. Seal joints within System and between System and adjacent construction.

B. Coordinate erection with the requirements of the hoist and man-lift, including tie-back and kicker connections to the floors, and door openings at the various floors.

C. Tolerances:

1. Tolerances for the building frame and other work are specified in other Sections. Make provisions for these tolerances, including a +/-1" concrete slab tolerance.

required for the structural silicone and silicone gaskets.

D. Thoroughly clean glazing pocket before setting glass. Solvents shall be compatible with aluminum, glass and glazing materials.

E. Remove and replace stops and apply sealants as required for a complete glass installation.

F. Defer glazing of openings which are obstructed during construction.

G. Replace any glass which breaks or sustains edge damage, surface damage, or damage to reflective coating as defined above.

3.03 FIELD TESTS

A. Field water tests in accordance with AAMA 501.2-83 (modified to exclude the appearance of any water at the interior) will be performed on selected completed portions of the wall at the Architect's direction. Should testing result in leakage, eliminate the causes of such leakage at no additional cost to the Owner. Remedial measures must maintain standards of quality and durability and are subject to approval. Provide powered scaffold or lift, hose and sufficient personnel to operate scaffold or lift and hose.

B. Periodically test sealants in place for adhesion, using methods recommended by sealant manufacturer. Promptly replace any sealant which does not adhere or fails to cure. A minimum of one test will be made at each floor on each elevation.

3.04 PROTECTION AND CLEANING

A. Protect against damage and contamination during construction. Clean surfaces as required to remove corrosive substances. At the conclusion of construction, clean all surfaces to the satisfaction of the Architect.

B. Provide written verification that cleaning agents are compatible with aluminum, glass, glazing materials and sealants.

C. Periodically remove from the site debris, excess materials and unused tools and equipment resulting from this work. At the conclusion of construction, leave the premises in a clean condition acceptable to the Architect and/or Owner.

Exhibit 2 – *450 N Street, Emergency Survey Investigation Report*, McGinnis Chen Associates LLP, Architects Engineers, November 15, 2005

McGinnis Chen Associates LLP
ARCHITECTS I ENGINEERS

450 N Street Emergency Survey Investigation Report

Department of General Services
State of California
RESD/State Owned
Buildings Planning Unit

The Ziggurat
707 3rd Street
Suite 4-405
Sacramento, CA
MCA Project No. 05167

15 November 2005

450 N Street
Emergency Survey
Investigation Report

Department of General Services
State of California
RESD/State Owned
Buildings Planning Unit

The Ziggurat
707 3rd Street
Suite 4-405
Sacramento, CA
MCA Project No. 05167

15 November 2005

McGinnis Chen Associates LLP
ARCHITECTS I ENGINEERS

15 November 2005

Mr. Tom Piette
Department of General Services – State of California
RESD/State Owned Buildings Planning Unit
The Ziggurat, 707 3rd Street, Suite 4-405
Sacramento, CA 95605

Re: BOE Building 450 N Street – 05167.00 RP
Subj: Glass Breakage Evaluation Report

Dear Mr. Piette:

Per your request, McGinnis Chen Associates, Inc. (MCA) conducted an investigation of the glass breakage at the Board of Equalization (BOE) Building (Project) located at 450 N Street in Sacramento. The following is our evaluation report for your review.

PROJECT BACKGROUND

The BOE building was built in 1991. The original construction, as pertinent to the curtain wall construction, is as follows:

Architect:	Dreyfus Blackford Architects
Curtain wall Consultant:	Eschbach Company, Inc.
General Contractor:	Hensel Phelps Construction Co.
Glazing Subcontractor:	Architectural Glass & Aluminum (AG&A)
Curtain wall Manufacturer:	Kawneer
Glass Supplier:	Tempglass Eastern, Inc.

The curtain wall system has experienced leaks in the past few years but there has not been any concern with the glass breakage issue until this year. A brief history of the glass breakage at the BOE building is listed below:

1.	1999	September	East, 7th floor	
2.	2001	August	South, 7th/8th floor	
3.	2001	August 14	West, 8th/9th floor	
4.	2005	January	South, 7th/8th floor	
5.	2005	September 21	South, 10th floor	(*2)
5A.	2005	September 24	South, 10th floor	(*1)
6.	2005	September	South, 7th/8th floor	(*2, *3)

*1: Replacement glass at this location cracked again, primarily due to observed edge defect at the window head.
*2: This location has been boarded up with plywood at this time.
*3: This pane broke after #5 broke (after 21 September) and is the pane that showed classic thermal break pattern as documented by Jeff Martin of MCA.

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Glass breakage occurrence has been sporadic in the early years of the building and was within the industry standard and expectation. As a reference point, industry standard allows 8 breaks in 1000 panes of glass (0.8%) in service situation. The BOE building has over 1,900 panes of spandrel glass and the failure percentage (6/1900 = 0.3%) is still entirely within the allowable industry standard. However, due to the quick succession of the last two breakage incidents and breakage of a replacement piece (5A, due to edge defect), there is an apparent serious condition that the glazing system maybe on the verge of an accelerated failure path. This would be a serious public safety issue that would require immediate attention.

A day after realization of the second incident of glass breakage, on emergency basis, DGS authorized MCA personnel to assess the glass breakage condition. MCA documented the cracked panel of spandrel glass in place and examined the cracked glass after its removal from the curtain wall. Subsequently, MCA conducted survey on the curtain wall to determine if there was other glass that maybe in imminent danger of cracking and falling out. After four days of survey on 9 drops of the curtain wall, covering 1364 windows, MCA feels reasonably sure that there were no signs to indicate further imminent glass breakage.

Further, as a safety measure, DGS erected pedestrian protection around the BOE tower on the North and East sidewalks and on the West side parking deck.

The following is MCA's analysis on the glass breakage issue at the 450 N Street building:

TECHNICAL BACKGROUND

Pertinent technical background information is provided here as basis for further discussion of the investigation work.

1. The building curtain wall consists of Kawneer 1600 series system, with a custom gold-color bull nose trim. The vision glass is a double pane insulation glass unit (IG unit) and the spandrel glass is a single pane heat strengthened glass with ceramic frit on the backside. MCA understands that glass breakage has occurred only at the spandrel glass, not at the vision glass.

2. Heat strengthened glass has a compression "skin" completely surrounding the central core of glass that is in tension. This compression skin imparts higher strength to resist failure by bending, impact, and thermal stress than conventional annealed glass. By ASTM C 1048 standards, heat strengthened glass has surface compression of 3,500 to less than 10,000 psi (pound per square inch) and edge compression between 5,000 and 9,750 psi. Fully tempered glass has surface compression of 10,000 psi or more. Heat strengthening in the range of 4,000 to 7,000 psi is probably the most desirable for most uses.

3. All heat-treated glass will break when the compression skin layer is penetrated. The edge of glass is especially vulnerable. Chips, scratches, or gouges that do not completely penetrate the compression layer can slowly propagate by external forces and result in breakage. These forces include wind pressure, thermal, and impact stress.

4. According to various sources of the glazing industry, heat strengthened glass can withstand temperature difference (Delta T or ∂ T) of 150 degrees F from center of glass to edge of glass, based on the 0.8% failure rate specification. The ∂ T calculation is a function of the glass' intrinsic material property (thermal expansion coefficient) and is not affected by the glass thickness.

5. A 1°F temperature difference introduces approximately 50 psi of tensile stress. A clean-cut annealed glass edge will resist a tensile stress of 2,400 psi. Assume glass edge T of 75 ° F and glass center T of 125 °F will introduce 2,500 psi of tensile stress, enough to crack anneal glass thermally. As a result, anneal glass is not used in spandrel glass application. The typical heat strengthened glass edge of 5,000 psi to 9,750 psi of compression is akin to the pre-stressing process to provide opposite (compressive) strength to resist the potential thermal tensile stress.

6. Glass in spandrel application can reach 200 to 220 °F in service condition. Aluminum frame, depending on color, can reach 160 to 180 °F in service.

7. There are specific pattern of thermal stress breakage for heat-strengthened glass. The typical pattern at the edge is a short (1" or so) clean and straight break at 90-degree angle to the edge of the glass. The break through of the glass is also at a 90-degree angle to the plan surface of the glass at the break.

   The break then travels in a long smooth curve across the glass and branches off in random directions (see Figure 1: Appendix C for typical thermal breakage).

8. There are patterns of exterior shadow that fall into three categories:

   a. Acceptable Shading: More than 50% of the glass is in shade.
   b. Marginal Shading: More than 25% of the glass is in shade.
   c. Harmful Shading: Less than 25% of glass area is in shade and more than 25% of the glass perimeter (linear edge footage) is in shade.

   The logic is that when large portion of the glass is in shade, the thermal gradient would not be large. The last category of harmful shading has large area of glass NOT in shade - meaning heat build up in the glass and large percentage of the glass edge in shade - meaning low temperature at the edge. The combination of the high center temperature and low edge temperature produces the highest thermal gradient and highest thermal stress.

INVESTIGATION

I. Methodology

MCA conducted a variety of tasks in the investigation of the spandrel glass breakage issue, including:

A. Examination of actual crack glass on the building
B. Survey of a large percentage of the spandrel glass on the building
C. Review of the original curtain wall shop drawings and available pertinent submittal

D. Extensive research of the glass breakage (result is summarized in the Technical Background above)
E. Computer simulation of the in-service thermal environment of the curtain wall
F. Field temperature measurement of exterior and interior spandrel surfaces

All of the above tasks contribute to the final evaluation and conclusion of the glass breakage study. Findings of each task are documented below.

II. Cracked Glass Observations

On 28 September, Jeff Martin of MCA rode the house swing stage to examine the cracked spandrel glass at 7th/8th floors on the south side of the building. The spandrel glass cracked in multiple branches starting at the lower left hand corner of the pane (Photos 1-2: Appendix B, and Figure 2: Appendix C). The break was within 3" to 4" of the splice joint between two vertical sections of the aluminum window frame (see Photo 1: Appendix B).

The glass was removed from the curtain wall frame. The broken glass edge was examined and photographed. It was noted that the glass had broken in the classic pattern attributable to thermal stress - 90-degree break both to the edge and surface of the glass (Photos 3, 4, and 5, Appendix B). There was noticeable chip at the edge of the glass, unfortunately, it could not be determined if the chipped edge was there before the break, thus contributing to the break, or caused by crushing during the break (Photo 5: Appendix B).

The outside temperature of 28 September reached 97 °F, and Mr. Martin reported that the glass temperature was extremely high on the outside surface. At the initial glass removal process, a cold blast of air was evident at the backside of the spandrel glass, and the ceiling soffit/plenum space is apparently somehow communicative with the interior air-conditioned space. The observed conditions set up a high temperature differential from center to edge of the spandrel glass.

As glass was removed, the cavity showed that a 4" section of the interior gasket has fallen away from the glass. The frame splice joint has a gap of 1/2" or so and the gasket is not being supported continuously at these locations. With the exterior glazing gasket suffering from accelerated deterioration and providing less pressure, the loose interior gasket was not unexpected. This loose gasket provides a path for the interior cold air to reach the glass edge, again further adversely impacting the thermal gradient.

Of importance is the position of the fiberglass insulation. The fiberglass blanket is in tight contact with the backside of the spandrel glass; this condition promotes build up of heat within the glass, especially in the middle region of the glass. The edge of the insulation is likely not perfectly cut and not as well insulated as compared to the center region of the glass. The insulation position further increases the thermal gradient from center to edge of the spandrel glass.

III. Survey of Spandrel Glass

As noted earlier, as long as the compression skin of the heat strengthened glass is not broken, small fissures or defects within the glass will not cause glass breakage. MCA personnel survey the spandrel glass to visually look for visible fracture in the spandrel glass

and to physically impact the glass to promote incipient crack to emerge. Throughout the survey and impact-check, no additional cracked glass was found. It appears that the areas examined are not in imminent risk of experiencing another break.

On the other hand, this survey does not preclude occurrence of thermal glass breakage that may still occur given the right combination of conditions.

IV. Review of Shop Drawings

In reviewing the original shop drawings, MCA learned that there are typical locations where a portion of the aluminum frame is ground away to allow structural attachment of the curtain wall frame to the floor slab (see Figure 3: Appendix C). As the frame is ground flat at the attachment point, a 10" or so portion of the frame does not have any means to hold the interior-glazing gasket. This condition allows every spandrel glass at least two locations of zero gasket contact. Gasket can become loose in such locations, providing less glazing support and allowing cold air to reach the glass edge.

V. Research Information

A brief summary of pertinent thermal-break information is provided in the Technical Background. MCA can provide further research information in our collection on request.

Aside from the technical background, sun-angle and building orientation was examined for the 450 N Street building. The research indicates that on a September day (September 1st, to be exact), sun reaches the south wall by approximately 8:45 a.m., becomes perpendicular to the south wall by 12:45 p.m., and continues to reach the south wall until sunset.

The sun angle is shallower in the morning (38° or so) and more up right (60° or so) during the mid day. By looking at the sun's path over the sky, the middle of the glass is almost always exposed to the sun (from 9:00 a.m. on - given that the frame protrudes 4" beyond the plane of glass - to possibly 5:00 p.m. or later, for approximately 8 hours). The left side of the glass - the west edge of the glass, in contrast, ceased to be exposed to the sun by 12:45 p.m. and stays in the shadow for the remainder of the day. The left edge thus receives about 3 3/4 hours of thermal exposure then cools down, while the center continues to build up with thermal exposure. This condition also adversely affects the spandrel glass thermal gradient.

By looking at the sun angle to the glass, it can be seen that less than 25% of the glass is in shade and, by 12:45 p.m. of a typical September day, the edge of the glass under the head section and next to the west jamb section would be in shade (50% of glass perimeter). This shade pattern is considered "harmful" by the glazing industry. This is yet another factor that adversely affects the thermal gradient within the spandrel glass.

VI. Thermal Stress Analysis Field Measured Temperature Data

MCA utilized a computer program available from Lawrence Berkeley Laboratory called THERM to approximate the thermal environment of the curtain wall. The purpose of the

THERM analysis is to establish a theoretical range of "in-service" temperature that the various part of the curtain wall may experience.

The analysis provides a graphic and numeric printout of the glass edge temperature under various conditions prescribed to simulate the service condition. A copy of the analysis is attached to this report as Appendix A.

In summary, the THERM analysis indicates that, for a given exterior surface temperature range of 120° to 180° F at the aluminum frame, with gasket in place and insulation in position, the edge of the glass in the shade will be approximately 114° to 165° F. This is calculated at the continuous aluminum frame - exterior gasket - spandrel glass - interior gasket - blanket insulation - interior cold air profile. The temperature at the middle of the spandrel glass could range between 160° and 220° F. (The 160° F is conservatively low for spandrel glass low temperature, corresponding to the 120° F of aluminum frame.) This would produce a temperature difference (from center to edge) of 46° F (160 -114 for the low range) to 55° F (220 - 165 for the high range) - enough to crack annealed glass, but quite safe for heat-strengthened glass.

When the interior gasket and edge of the insulation is removed, the range of glass edge temperature drops to approximately 110° (109.8) to 158° (158.4) F. This increased the differential to 50° F (160 -110 for the low range) to 62° F (220 - 158 for the high range).

Two factors not accounted for in the THERM are the dynamic flow of constant cool air from the air condition system and the moving shadow that put the south wall west edge of the spandrel glass in the shade for half of a day. Field temperature measurements were taken to supplement the computer analysis.

The field temperature measurement is listed as follows:

Temperature measurements were taken from 10:00 a.m. to 10:30 a.m. (after approximately of 1 hour of sun exposure on the south elevation). Ambient exterior air temperature was 70°F.

1.	Exterior center of spandrel glass:	109
2.	Exterior edge of spandrel glass in morning sun:	110
3.	Exterior edge of spandrel glass in shade:	89
4.	Exterior aluminum frame:	98
5.	Interior center of spandrel glass:	94
6.	Interior edge of spandrel glass in morning sun:	98
7.	Interior edge of spandrel glass in shade:	87
8.	Interior ceiling:	77

- The center-to-edge in shade difference is (109 - 87) = 21° F after only brief sun exposure.
- There is a temperature difference of 15° F (109-94), 12° F (110-98), and 2° F(89-87) from exterior to interior surfaces at center of glass, edge in sun, and edge in shade respectively. The higher the exterior temperature, the larger the temperature difference between the exterior and the interior surfaces.

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If the aluminum frame temperature rises to 160° F, one can expect the glass to reach 200° F, with the glass center portion being fully exposed to sun for the rest of the day. At the time just before the left edge of the glass goes into shade, one would expect the temperature there to be roughly equivalent to the center of glass. With half of its total daily sun exposure, the surface temperature would not be at the high temperature yet. However, a temperature of 180° F would seem reasonable.

The center of glass temperature would continue to climb to reach 200° F, while the edge in mullion's shade would drop for the rest of the day. The west edge of spandrel glass in shade would likely drop from 180° F down to temperature somewhat higher than the interior air temperature (the interior ceiling temperature was 77° F). And as noted earlier, the higher the exterior surface temperature, the larger the interior and exterior temperatures difference would be. If the glass edge drops to 158° F (based on THERM), the field data indicate a possible further lowering of the interior surface temperature.

For exterior surface temperature of 89° F, the measured interior temperature difference was 2 degrees. For exterior surface temperature of 109° F, the measured interior difference was 15. One would expect that for an exterior temperature of 158° F, a measured interior temperature difference could be in the range of 30° F or more. This could drop the interior glass edge temperature to 128° F or so, creating a spandrel center to edge difference of (200 - 128) = 72° F.

Under more extreme conditions, when the exterior temperature rises beyond 100° F, which is not unusual in Sacramento, the interior air conditioned space will remain relatively unchanged (with HVAC system), the temperature difference could reach well into 90° F plus. At that range, the actual temperature difference is beginning to get closer to the design limit of 150° F (as noted by a glazing manufacturer).

EVALUATION & RECOMMENDATIONS

After reviewing the field data, research information, shop drawings, actual building configuration, and weather parameters, MCA believes that the glass breakage is a thermal stress break. Although the break is not caused solely by thermal stress, all factors combined to cause the breakage observed recently.

The likely scenario is summarized as follows:

- The heat strengthened spandrel glass has a compression skin layer surrounding the entire piece of glass. This compression layer imparts greater strength to the glass to resist breakage due to bending, impact, and thermal stress. This compression layer is approximately 20% of the glass thickness on each side and as long as this compression skin is not fully penetrated, the glass will remain intact. It is possible that a small chip at the glass edge may have been present before the break.

- Small edge or surface defects, such as scratches, gouges, or chips, if contained within the compression layer, will not break the glass. However, over time, bending, thermal, and impact stresses may propagate the small cracks through the compression layer and then cause what appears to be spontaneous break.

- The current curtain wall exterior shading pattern is what the glazing industry considers harmful: A) Less than 25% of total glass area is in shade, and B) more than 25% of the glass perimeter lineal footage is in shade. This configuration sets up greater center-to-edge thermal gradient.

- The insulation directly behind the glass without space to allow air to move exacerbates the heat build up in the center region of the glass. The edge of the insulation does not cover the edge of the glass and is also not as tight to the glass as the center, further increasing the thermal gradient.

- As sun moves through the southern sky during the day, the glass experiences different build up of heat. The right jamb is in shade and a small portion of the head (lower sun angle) is in shade in the morning. By about 12:45 p.m. or so, the sun is perpendicular to the south wall and only the head is in shade. However, beyond that point, the left jamb stays in the shade for the remainder of the day while the center of the glass continues to gain heat. This sets up greater thermal differential through the rest of the day.

- The notched-out aluminum frame at anchor and discontinuity of frame at splice joint (every two floors) create gaps allowing cold air to come in contact directly with the edge of the glass.

- The gold-tone mullion just above center of the glass casts a somewhat constant shadow in the center region of the spandrel glass. Its effect may or may not be positive (it puts more glass in shadow, helping to reduce total thermal gradient. However, it may also thermally divide the glass into two regions. This is still being investigated).

- Based on empirical data from prior projects and industry resources, glass can reach temperature in the 200° F to 220° F and the curtain wall frame can reach 160° F to 180° F. Based on the frame being at 160° F and center of glass at 200° F, our computer simulation program produces glass edge temperature in the 130° F range. This is a temperature difference of 70° to 90° F; not enough to cause breakage on a heat-strengthened glass. But when the gasket is loose and pulled away, the glass edge temperature drops to 110° F increasing the temperature difference to 90 to 110 degrees range.

- With gasket being loose, the temperature difference is 110 degrees, getting closer to the 153.6 degree limit as set by the glazing manufacturer (Viracon uses 153.6° F as guideline).

- The thermal stress from the elevated temperature differential imposes thermal stress at the glass edge and likely pushed some form of glass edge defect past the compression skin and caused the thermal break observed.

The fact that the temperature differential is not at the limit, is re-assuring, and is logical. If THERM calculations had indicated a much higher thermal differential, more glass probably would have been broken thermally throughout the history of the building.

MCA believes the above is reasonably true of actual conditions at the building. MCA recommends testing of the glass to find out what its true compression values are before proceeding with the design of corrective measures.

Modification of the wall cavity (insulation/fire-safing) becomes important during the remedial work. 100% inspection of the spandrel glass edge will be required during remedial work - some replacement is expected (possibly 10% or even higher), to eliminate as many potential defects as possible.

Considering all factors, the current total number of breakage is still well within industry tolerance for glass breakage of 0.8% (BOE has about 1,900 spandrel glass, allowing 15 pieces of breakage). The thermal stress in the coming rainy season should be lower than the past summer (one would surely expect it) therefore reducing the potential for glass breakage. In addition, the complexity of the remedial work and necessary testing for the existing glass properties would make rushing into remedial work this winter a problematic, if not unsafe scenario. MCA feels it would be prudent to accelerate the preliminary design and testing now to complete the design development as soon as possible, complete the bid documents through the winter season, and bid the work late winter to start construction after this rainy season.

If you have any questions, please do not hesitate to contact MCA.

Sincerely,

Yi-Tso Jeff Chen

YJC:gm

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APPENDIX A – THERM Analysis

Introduction to THERM 5.2

THERM is a state-of-the-art, Microsoft Windows™-based computer program developed at Lawrence Berkeley National Laboratory (LBNL) for use by building component manufacturers, engineers, educators, students, architects, and others interested in heat transfer. Using THERM, you can model two-dimensional heat-transfer effects in building components such as windows, walls, foundations, roofs, and doors; appliances; and other products where thermal bridges are of concern. THERM's heat-transfer analysis allows you to evaluate a product's energy efficiency and local temperature patterns, which may relate directly to problems with condensation, moisture damage, and structural integrity.
THERM's two-dimensional conduction heat-transfer analysis is based on the finite-element method, which can model the complicated geometries of building products.

Analysis Performed by McGinnis Chen Associates, Inc. (MCA)

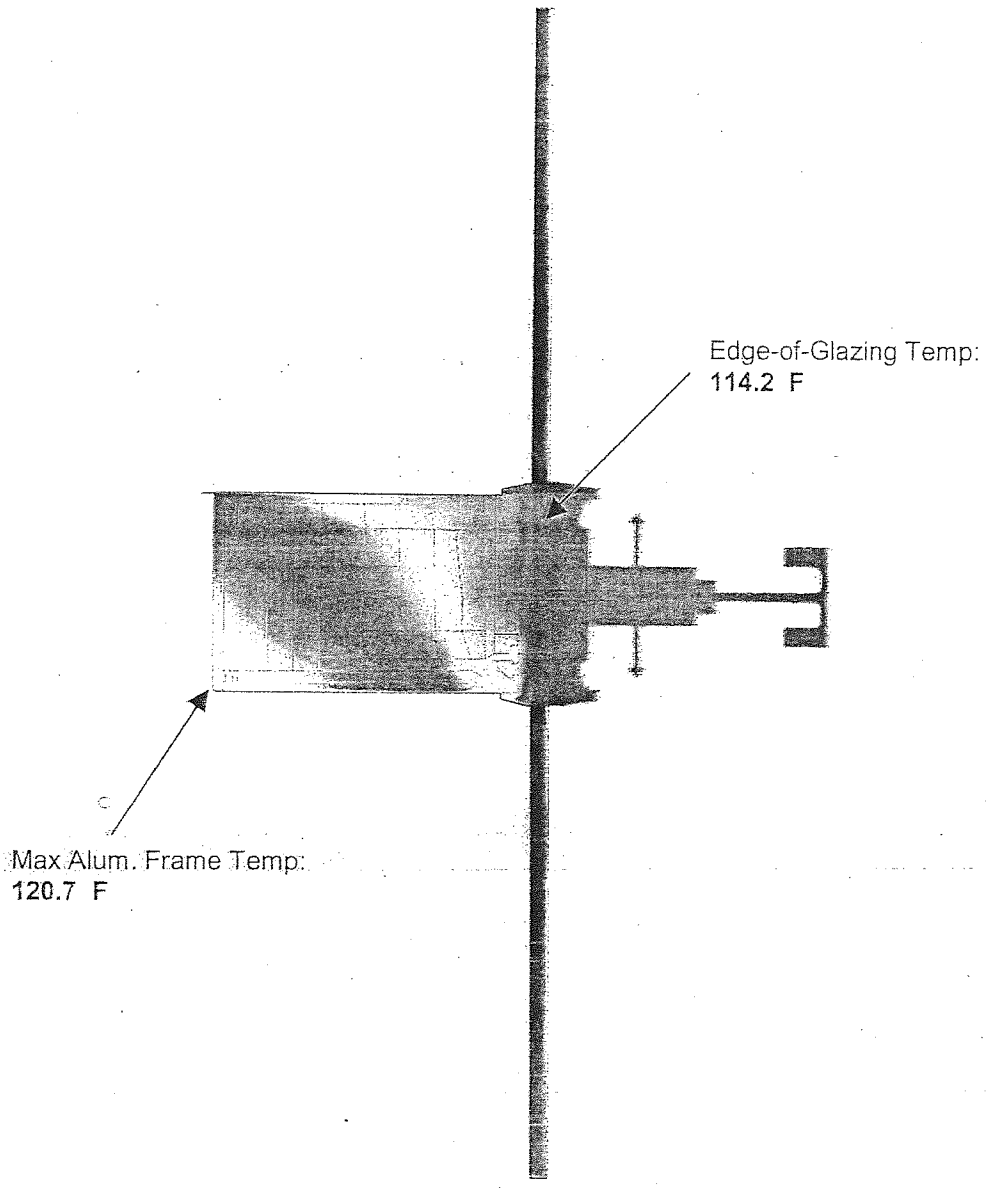
The following pages are results from two-dimensional heat transfer modeling performed by MCA for the Capitol Square Building at 450 N Street, Sacramento, California. The subject of MCA's analysis was the vertical divider between two lights of spandrel glass. This profile was modeled under the following three conditions:

A. Typical profile as-designed with gaskets in place on interior and exterior.
B. Typical profile with interior gaskets out of place, allowing for increased ventilation in the frame cavity.
C. Profile at anchor connections where the profile is milled out and provides no lateral support for interior gaskets.

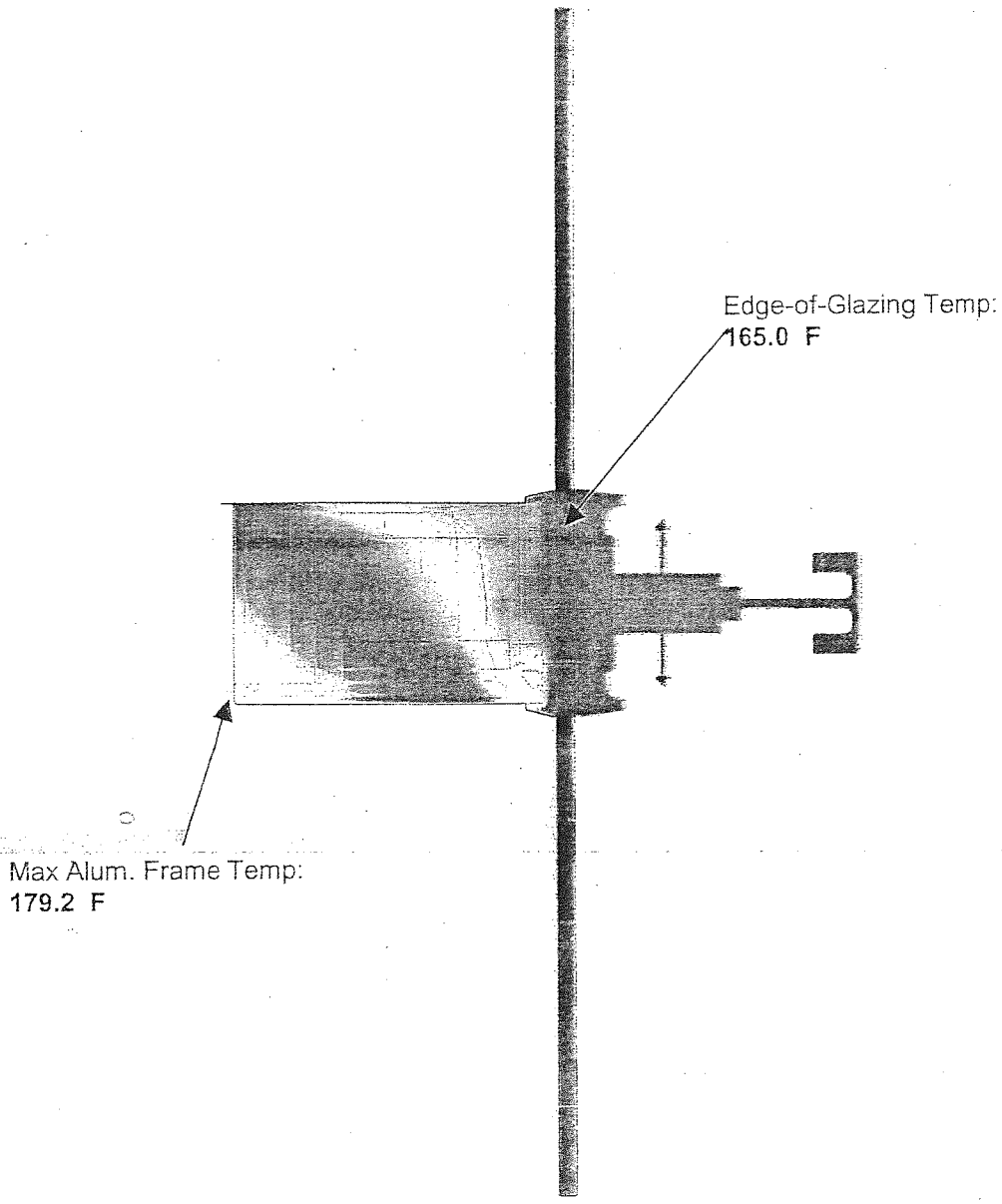
The maximum assumed temperature of the center-of-glazing used in MCA's analysis was 220 °F, and based on this value, a conservative range of aluminum temperatures was used to evaluate the temperature differential between center- and edge-of-glazing. The range varied from 120 °F to 180 °F, where 120 °F is presumed to be the lowest temperature that the aluminum frame would achieve while the center-of-glazing is simultaneously 220 °F.

Each of the above three conditions was modeled for an interior ambient temperature of 69.8 °F and exterior ambient temperature of 90 °F. The profiles were then subjected to four boundary conditions with the temperature of the exterior face of the aluminum frame varying between 120 °F, 140 °F, 160 °F, and 180 °F. The results of this modeling are shown graphically in color infrared over the various profile conditions. Included in Appendix A are the most extreme results, which are each of the three profile conditions (A, B, and C) modeled with boundary conditions at 120 °F and 180 °F.

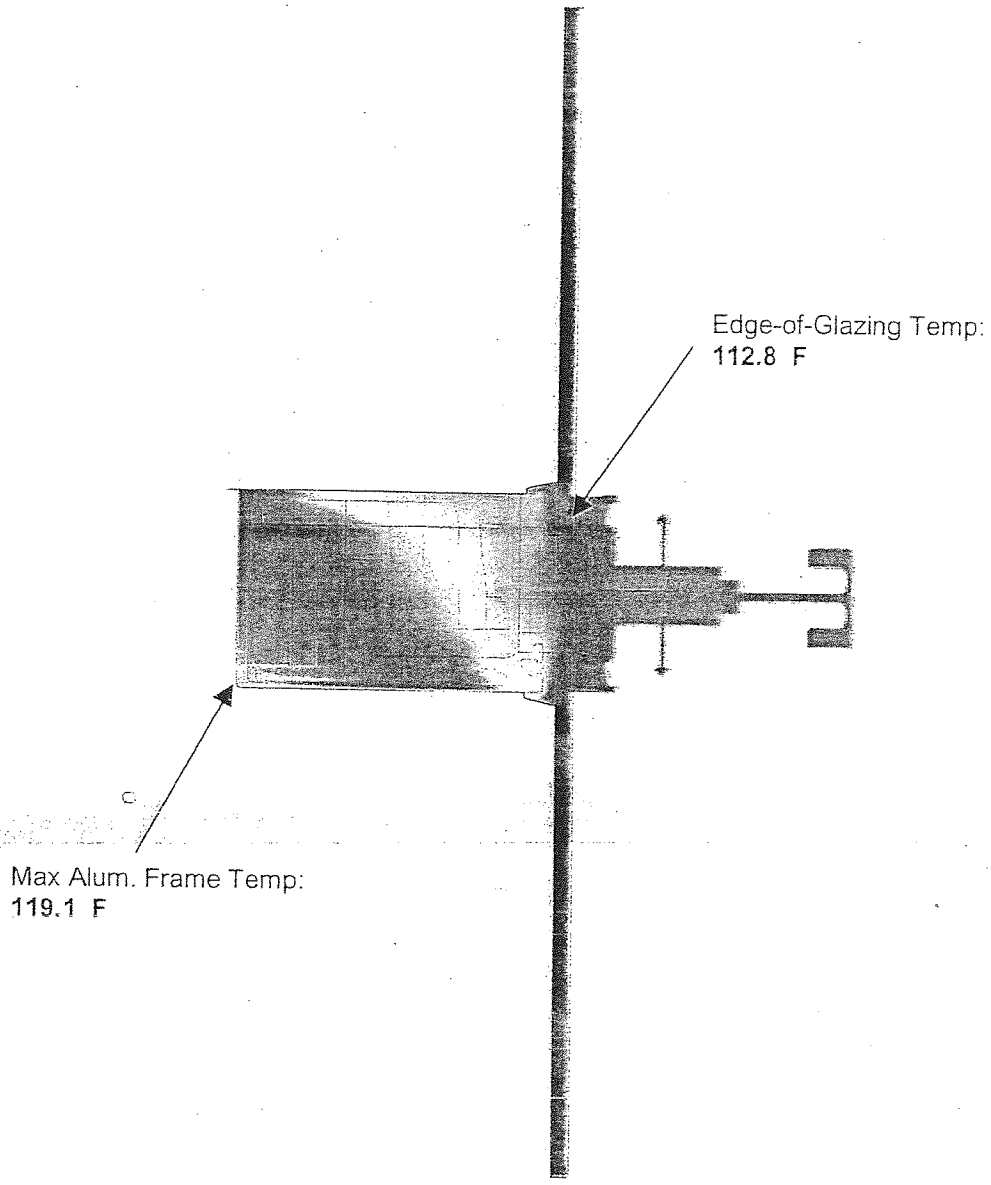
CONDITION A	Typical As-Designed Profile of Vertical Divider at Spandrel
BOUNDARY CONDITIONS	Exterior Face of Aluminum Frame at 120 °F


Edge-of-Glazing Temp:
114.2 F
Max Alum. Frame Temp:
120.7 F

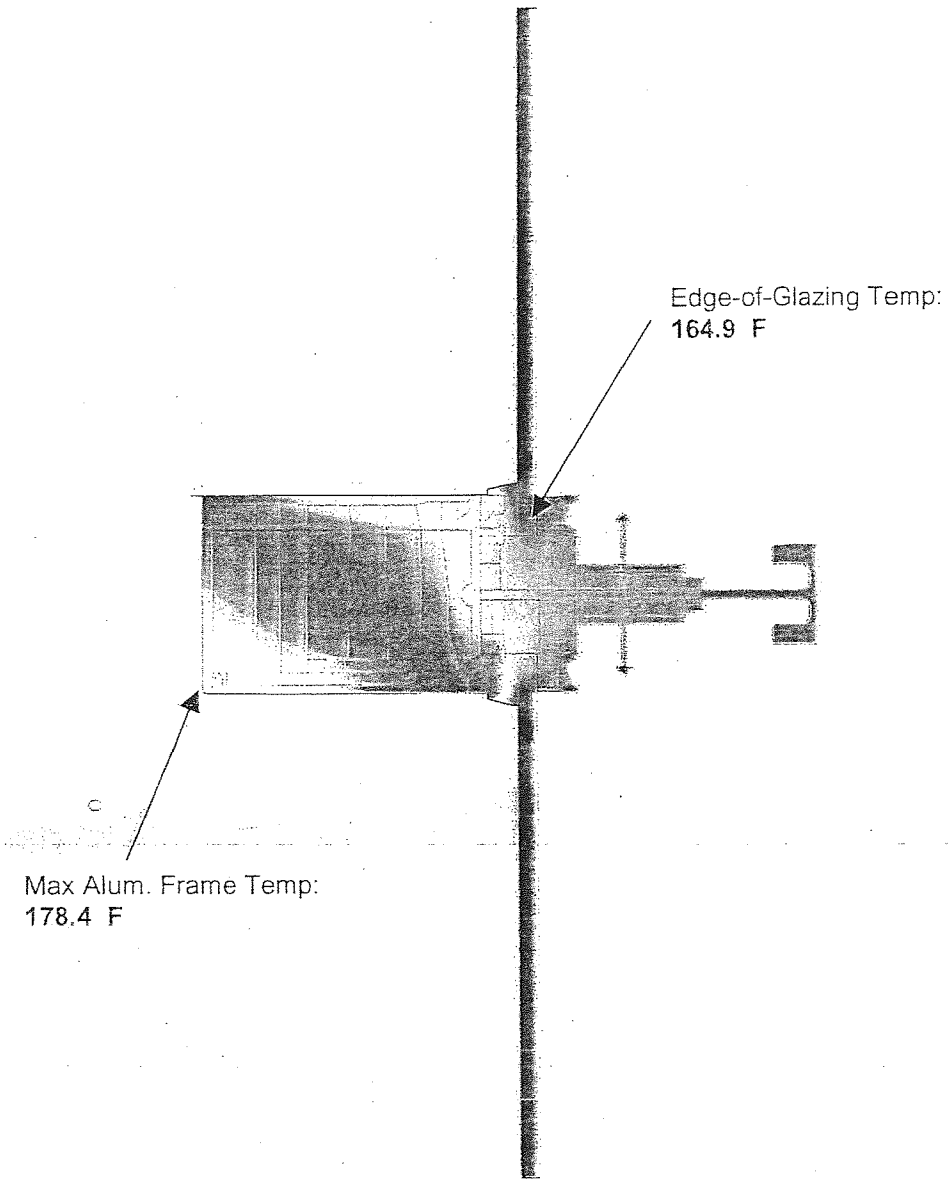
CONDITION A	Typical As-Designed Profile of Vertical Divider at Spandrel
BOUNDARY CONDITIONS	Exterior Face of Aluminum Frame at 180 °F


Edge-of-Glazing Temp:
165.0 F
Max Alum. Frame Temp:
179.2 F

CONDITION B	Typical Profile of Vertical Divider at Spandrel Without Interior Gaskets
BOUNDARY CONDITIONS	Exterior Face of Aluminum Frame at 120 °F


Edge-of-Glazing Temp:
112.8 F
Max Alum. Frame Temp:
119.1 F

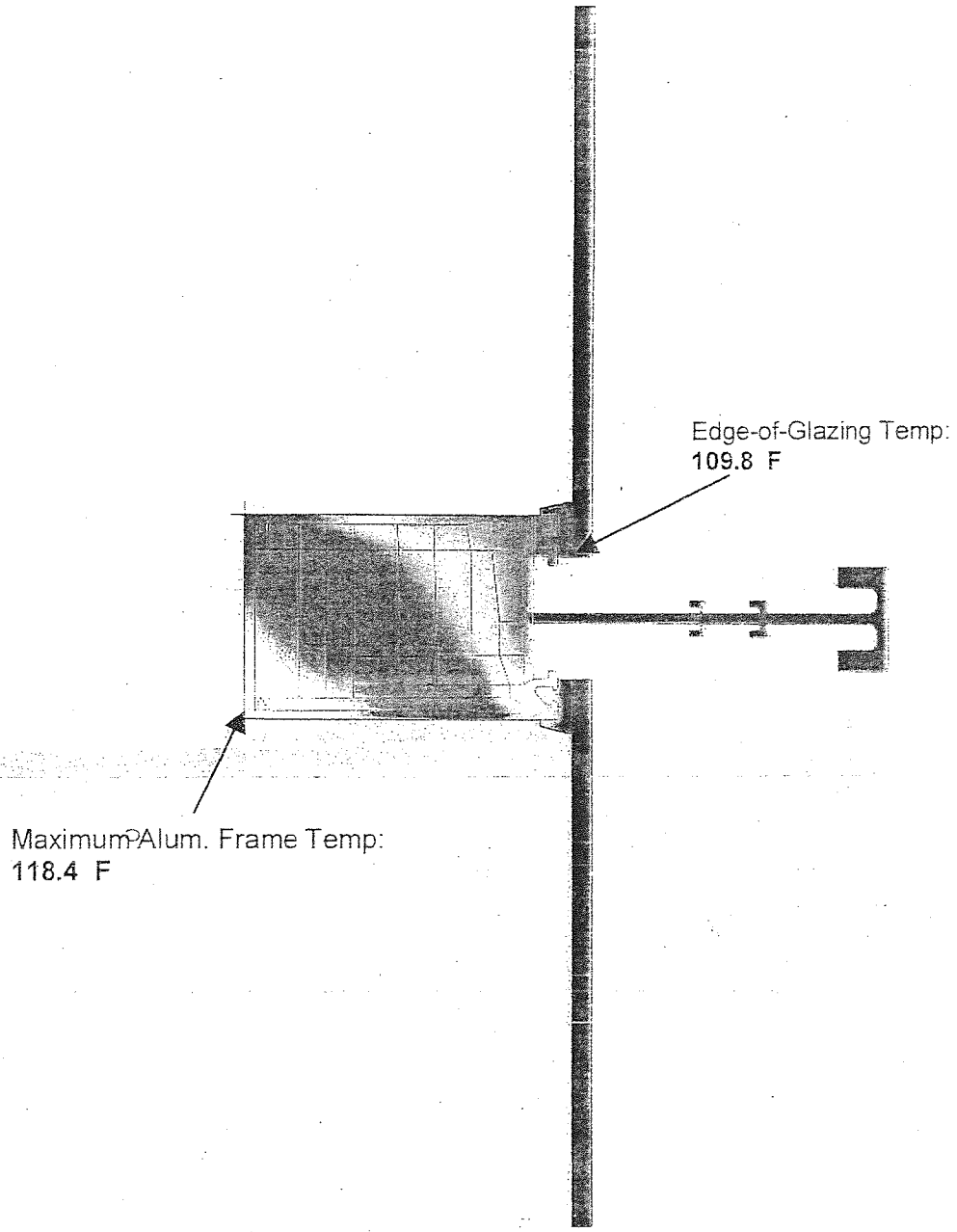
CONDITION B	Typical Profile of Vertical Divider at Spandrel Without Interior Gaskets
BOUNDARY CONDITIONS	Exterior Face of Aluminum Frame at 180 °F


Edge-of-Glazing Temp:
164.9 F
Max Alum. Frame Temp:
178.4 F

CONDITION C Milled Profile at Anchor Connections Without Gaskets

Exterior Face of Aluminum Frame at 120 °F

BOUNDARY CONDITIONS

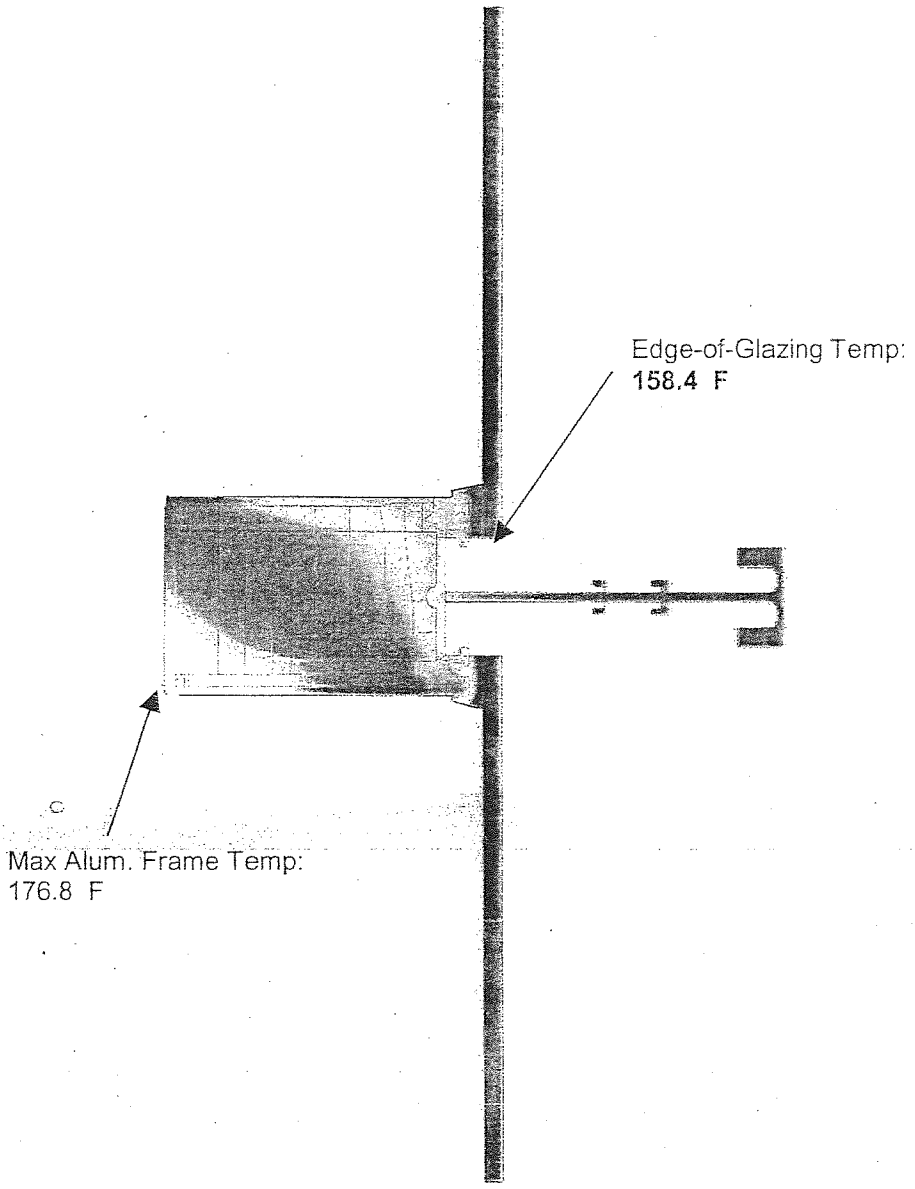

Edge-of-Glazing Temp:
109.8 F
Maximum Alum. Frame Temp:
118.4 F

CONDITION C

Milled Profile at Anchor Connections Without Gaskets

Exterior Face of Aluminum Frame at 180 °F

BOUNDARY CONDITIONS


Edge-of-Glazing Temp:
158.4 F
Max Alum. Frame Temp:
176.8 F

APPENDIX B – INVESTIGATION PHOTOGRAPHS

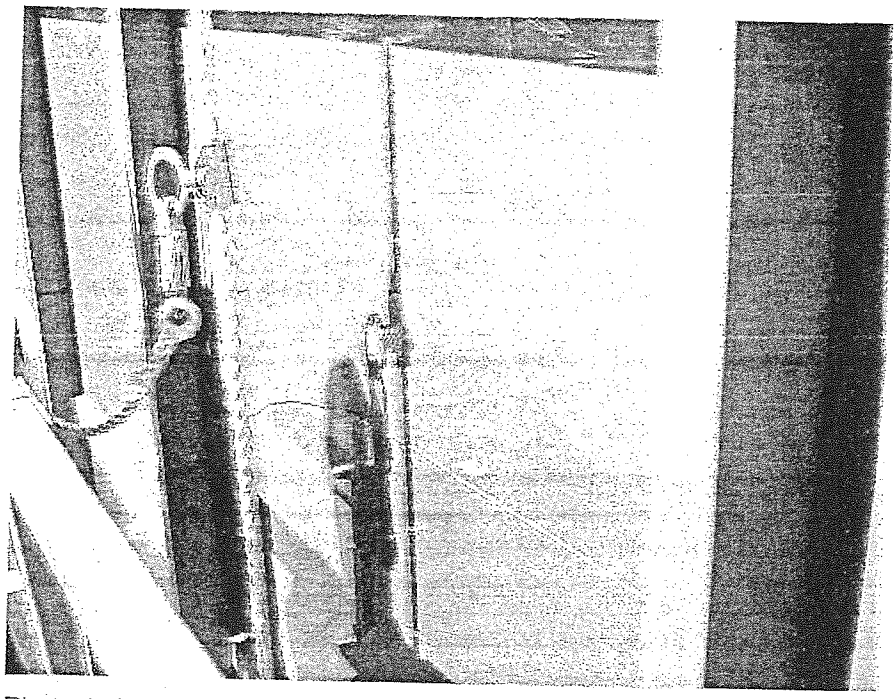


Photo 1: Cracked spandrel glass near gold bull-nose attachment

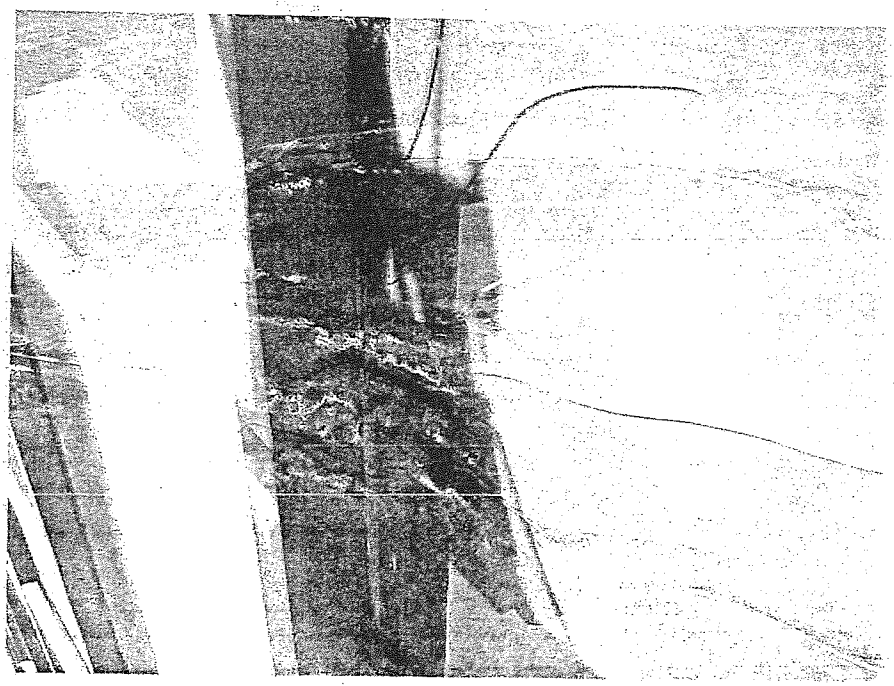


Photo 2: Close-up view of the crack origins

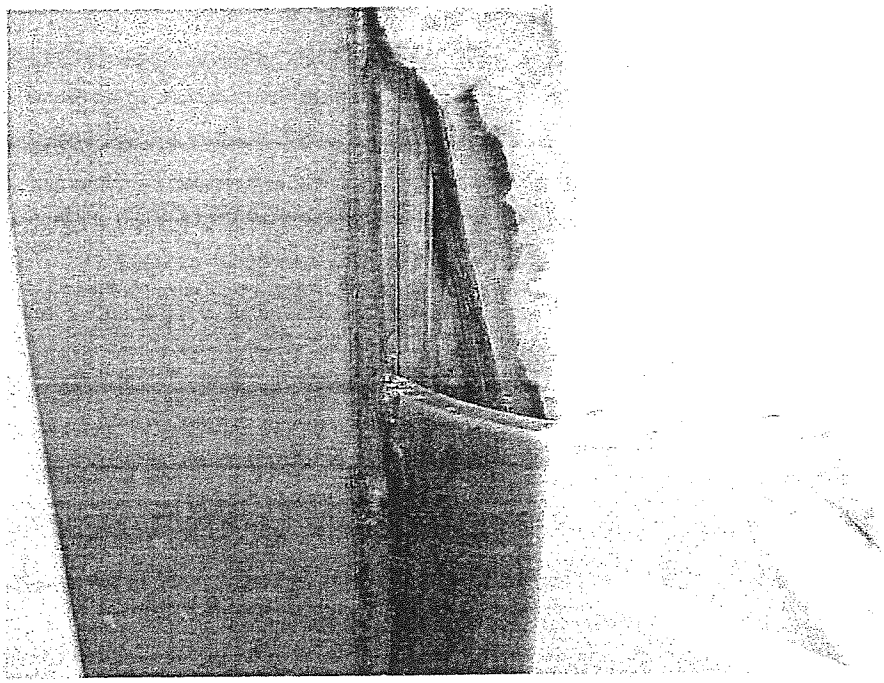


Photo 3: The origin of the break is at a 90 ° angle from the edge

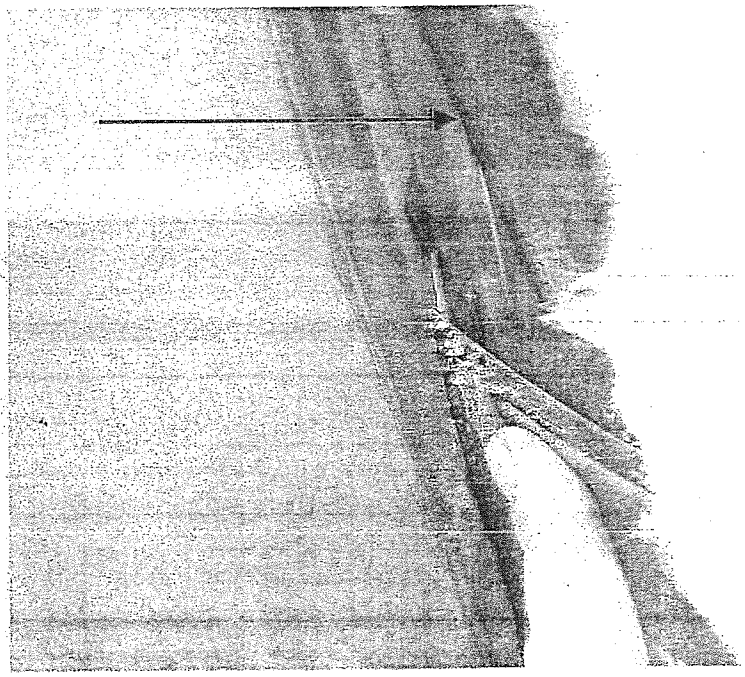


Photo 4: View of interior gasket out of place directly behind origin of crack

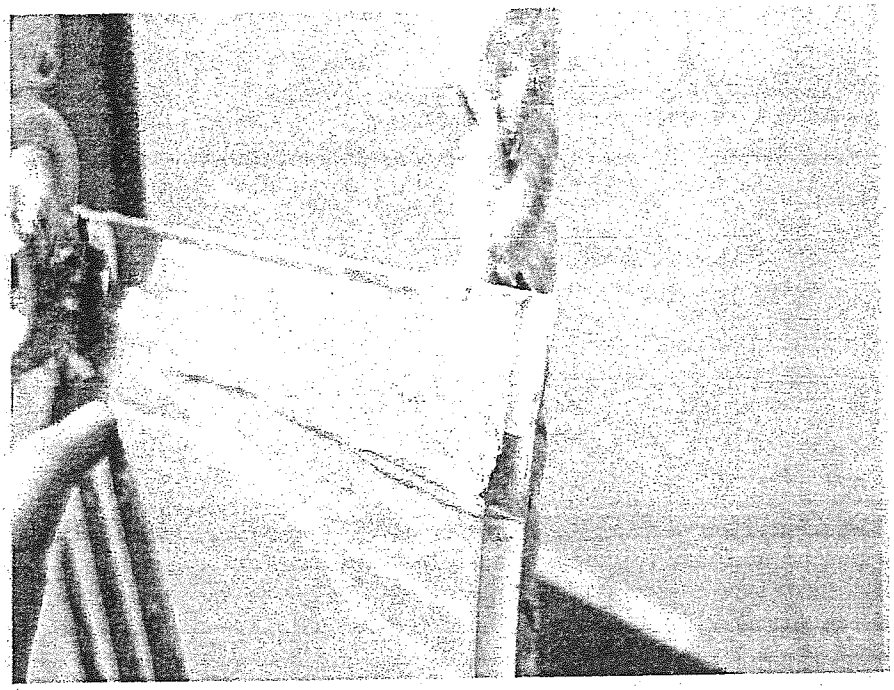
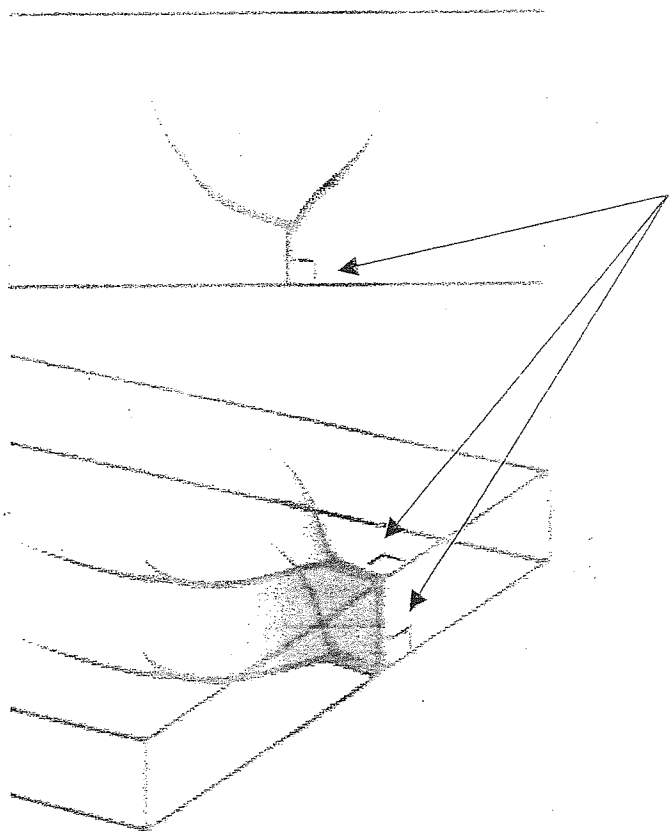


Photo 5: Damaged edge of glass

APPENDIX C – FIGURES



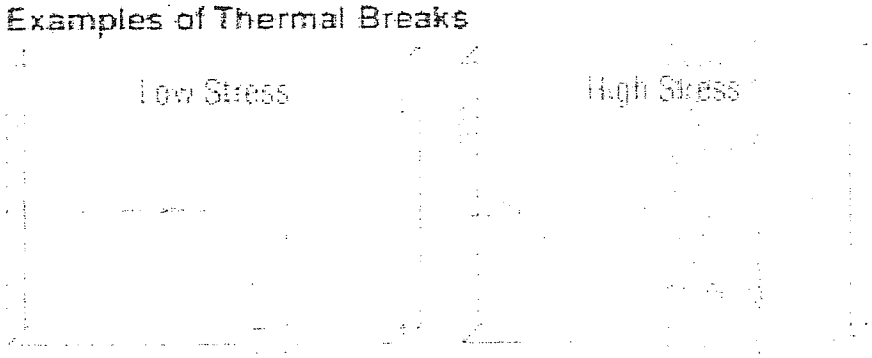


Figure 1: Typical Thermal Break Pattern in Glass
(Taken from www.glassresource.com)

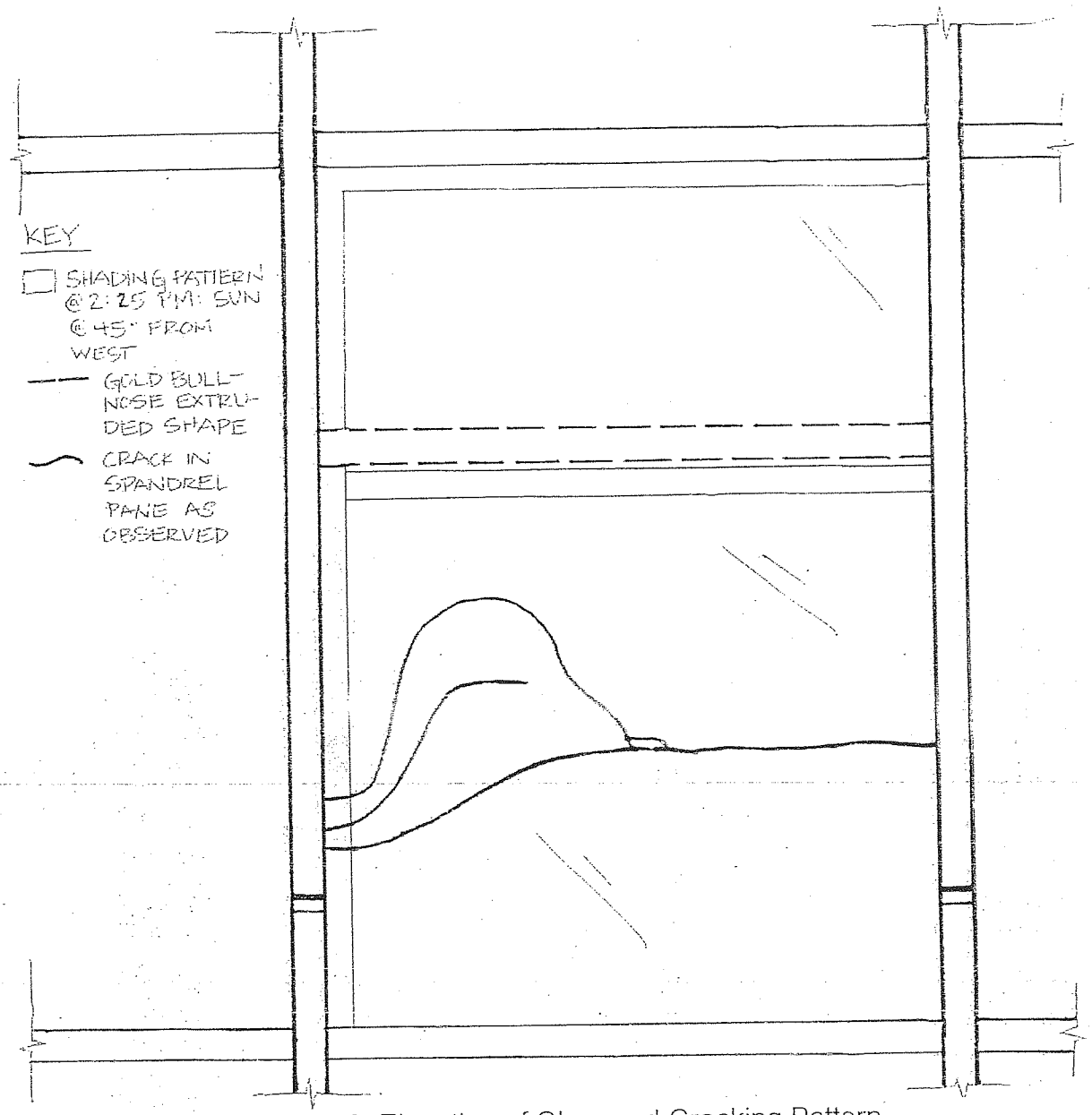


Figure 2: Elevation of Observed Cracking Pattern

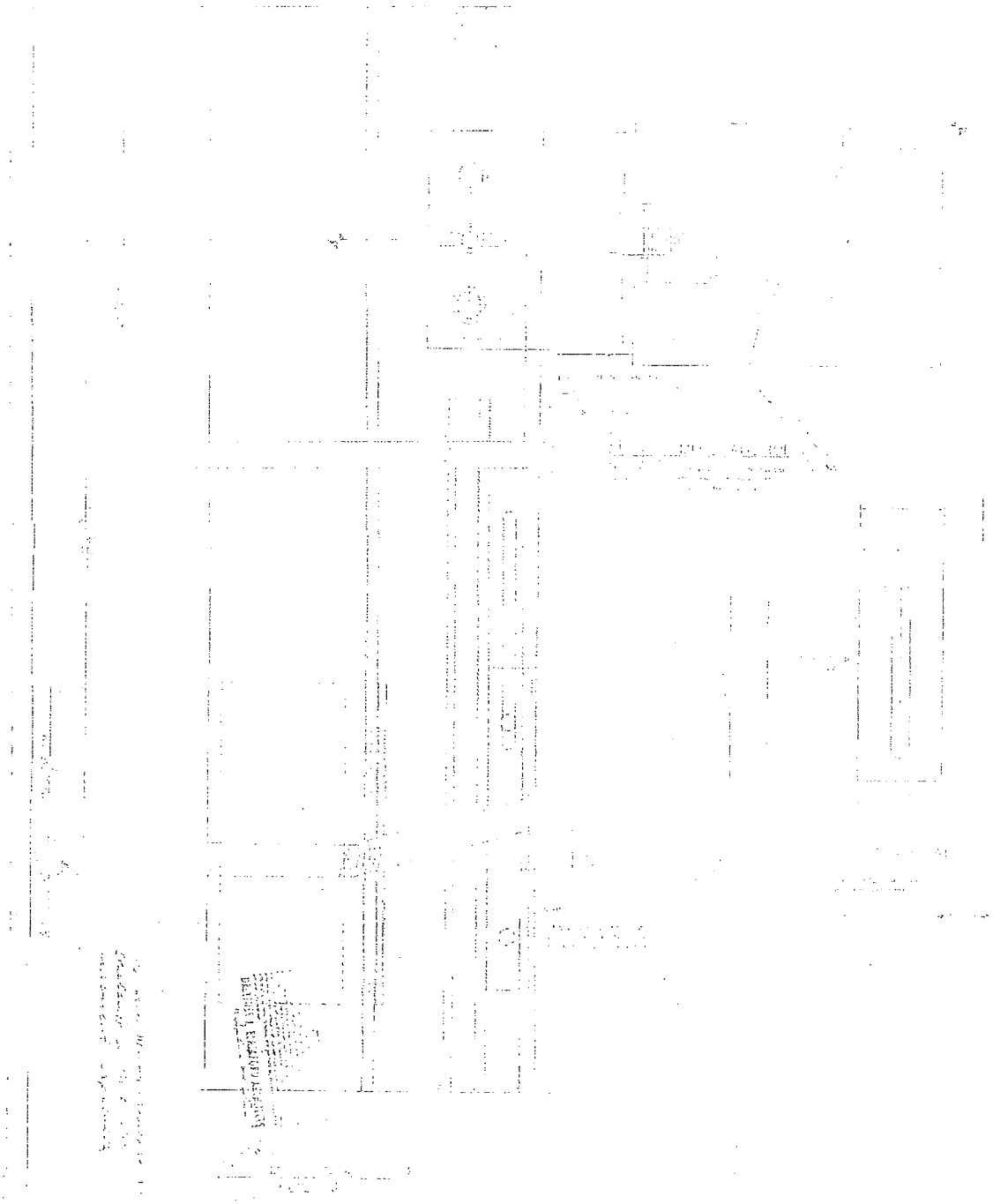


Figure 3: Section Detail at Anchor Connection

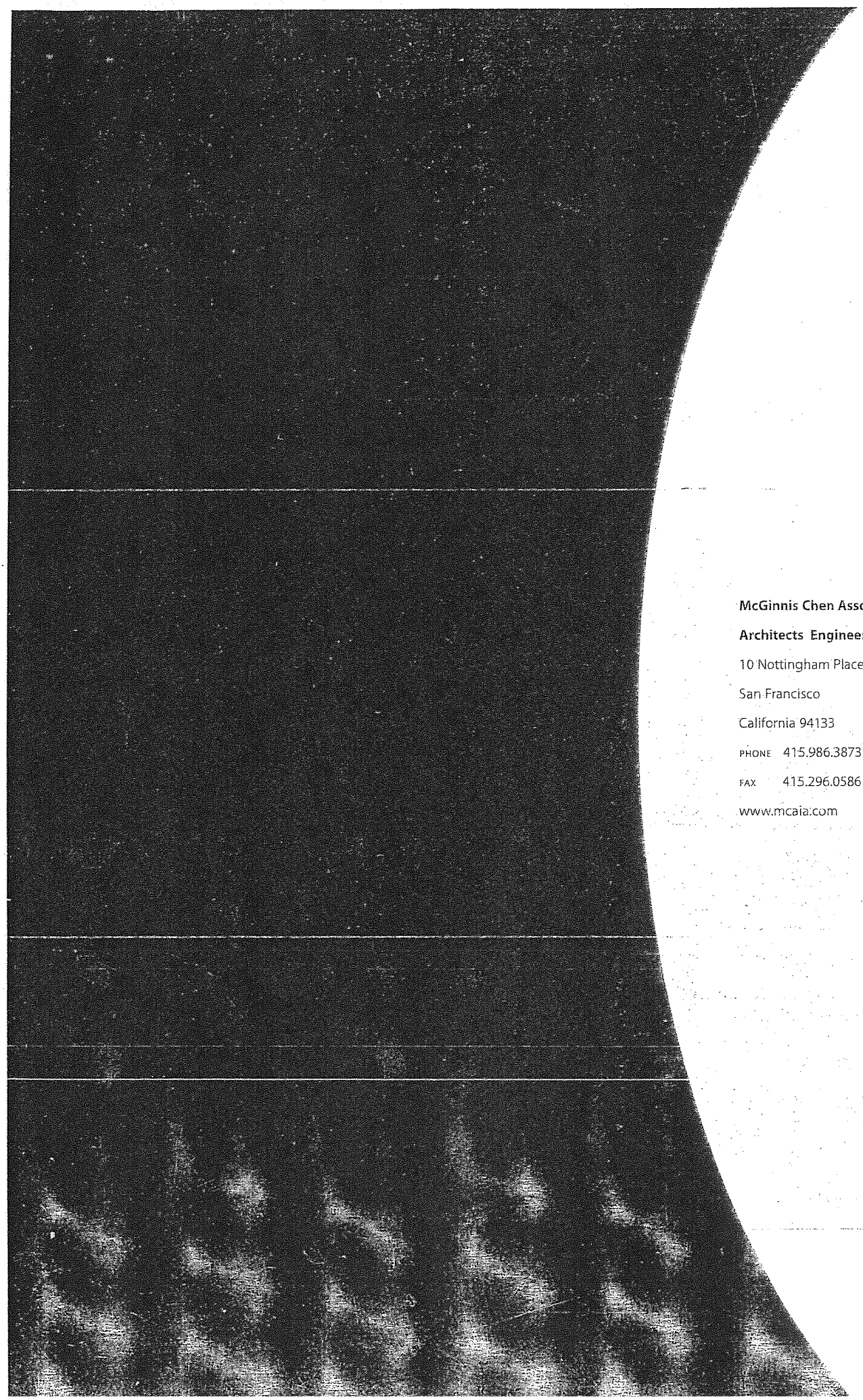


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Exhibit 3 – Drawings, 450 N Street Curtainwall and Balcony Remediation, April 19, 2006, (JR Roberts As-Builts), McGinnis Chen Associates, Inc.

JR ROBERTS AS-BUILTS

450 N STREET

CURTAINWALL AND BALCONY REMEDIATION

STATE OF CALIFORNIA
DEPARTMENT OF GENERAL SERVICES
SACRAMENTO, CA

STATE PROJECT NO. 120535

SFM FILE NO. - 01-34-11-0823-000

ABBREVIATIONS

A.B.	ANCHOR BOLT	F.D.	FLOOR DRAIN	(R)	REMOVE
A/C	AIR-CONDITIONING	FDN.	FOUNDATION	R.	RISER
ACOUS.	ACOUSTICAL	FIN.	FINISH	R&S	ROD & SEALANT
A.D.	AREA DRAIN	FL.	FLOOR	RAD.	RADIUS
ADJ.	ADJUSTABLE	FLASH.	FLASHING	R.D.	ROOF DRAIN
AGGR.	AGGREGATE	F.O.C.	FACE OF CONCRETE	REF.	REFERENCE
AL.	ALUMINUM	F.O.F.	FACE OF FINISH	REINF.	REINFORCED
ALT.	ALTERNATE	F.O.S.	FACE OF STUDS	REQ.	REQUIRED
ANOD.	ANODIZED	F.S.	FULL SIZE	RESIL.	RESILIENT
APPROX.	APPROXIMATE	FT.	FOOT OR FEET	RGTR.	REGISTER
ARCH	ARCHITECTURAL	FTG.	FOOTING	RM.	ROOM
ASPH.	ASPHALT	FURR.	FURRING	R.O.	ROUGH OPENING
				R.W.L.	RAIN WATER LEADER
BD.	BOARD	GA.	GAUGE		
BITUM.	BITUMINOUS	GALV.	GALVANIZED	S.	SOUTH
B.F.	BASE FLASHING	GL.	GLASS	S.A.M.	SELF ADHERED MEMBRANE
BLDG.	BUILDING	GND.	GROUND	S.C.	SOLID CORE
BLK.	BLOCK	GR.	GRADE	SCHED.	SCHEDULE
BLKG.	BLOCKING	G.S.M.	GALVANIZED SHEET METAL	SECT.	SECTION
BLW.	BELOW	GYP.	GYPSUM	SGD.	SLIDING GLASS DOOR
BM.	BEAM			SH.	SHELF
BOT.	BOTTOM	H.B.	HOSE BIBB	SHT.	SHEET
BSMT.	BASEMENT	H.C.	HOLLOW CORE	SHTG.	SHEATHING
BTWN.	BETWEEN	HDG	HOT DIPPED GALVANIZED	SIM.	SIMILAR
B.U.R.	BUILT-UP ROOFING	HGT.	HEIGHT	SQ.	SQUARE
		H.M.	HOLLOW METAL	S.ST.	STAINLESS STEEL
C.B.	CATCH BASIN	HORIZ.	HORIZONTAL	STA.	STATION
CEM.	CEMENT	H.P.	HIGH POINT	STD.	STANDARD
CFL.	COUNTERFLASHING	HR.	HOUR	STL.	STEEL
C.I.	CAST IRON	H.W.	HOT WATER	STOR.	STORAGE
C.I.P.	CAST-IN-PLACE			STRL.	STRUCTURAL
CLG.	CEILING	I.D.	INSIDE DIAMETER (DIM.)	SYM.	SYMMETRICAL
CLKG.	CAULKING	INT.	INTERIOR		
CLR.	CLEAR	INV.	INVERT	T.C.	TOP OF CURB
CMU	CONCRETE MASONRY UNIT	JT.	JOINT	TEL.	TELEPHONE
CNTR.	COUNTER			T. & G.	TONGUE & GROOVE
COL.	COLUMN	'L'	ANGLE	THK.	THICK
COMP.	COMPOSITION	L.B.	LAG BOLT	THRESH.	THRESHOLD
CONC.	CONCRETE	L.P.	LOW POINT	T.P.	TOP OF PAVEMENT
CONT.	CONTINUOUS	LT.	LIGHT	T.S.	TUBE STEEL
CORR.	CORRIDOR	LVR.	LOUVER	T.W.	TOP OF WALL
CTR.	CENTER	L.W.	LIGHTWEIGHT	TYP.	TYPICAL
CTSK.	COUNTERSUNK			UNF.	UNFINISHED
DBL.	DOUBLE	MAX.	MAXIMUM	U.O.N.	UNLESS OTHERWISE NOTED
DEPT.	DEPARTMENT	M.B.	MODIFIED BITUMEN	VERT.	VERTICAL
DET.	DETAIL	MECH.	MECHANICAL	VEST.	VESTIBULE
D.D.	DECK DRAIN	MEMB.	MEMBRANE	V.I.F.	VERIFY IN FIELD
D.F.	DOUGLAS FIR	MET.	METAL	V.S.	VENT STACK
DIA.	DIAMETER	MFR.	MANUFACTURER		
DIAG.	DIAGONAL	MIN.	MINIMUM	W.	WEST
DIM.	DIMENSION	MISC.	MISCELLANEOUS	W/	WITH
DN.	DOWN	MTD.	MOUNTED	WD.	WOOD
D.P.	DAMPPROOFING	MTL.	MATERIAL	WIN.	WINDOW
DR.	DOOR	MUL.	MULLION	W/O	WITHOUT
DS.	DOWNSPOUT			W.O.	WHERE OCCURS
D.S.P.	DRY STANDPIPE	N.	NORTH	WP.	WATERPROOF
DTL.	DETAIL	(N)	NEW	WT.	WEIGHT
DWG.	DRAWING	N.I.C.	NOT IN CONTRACT	W.W.F.	WELDED WIRE FABRIC
		NO.	NUMBER		
E.	EAST	NOM.	NOMINAL		
(E)	EXISTING	N.T.S.	NOT TO SCALE		
EA.	EACH				
E.B.	EXPANSION BOLT	O/	OVER		
E.J.	EXPANSION JOINT	O.A.	OVERALL		
EL.	ELEVATION	O.C.	ON CENTER		
ELAS.	ELASTOMERIC	O.D.	OUTSIDE DIAMETER (DIM.)		
ELEV.	ELEVATION	O.F.	OVERFLOW		
ENCL.	ENCLOSURE	O.F.D.	OVERFLOW DRAIN		
EQ.	EQUAL	OPNG.	OPENING		
EQPT.	EQUIPMENT	OPP.	OPPOSITE		
EXP.	EXPANSION				
EXPO.	EXPOSED	P.C.	PHOTO CELL		
EXT.	EXTERIOR	PL.	PLATE		
		PLAS.	PLASTER		
		PLYWD.	PLYWOOD		
		PRCST.	PRE-CAST		
		PT.	POINT		
		P.T.	PRESSURE TREATED		
		P.T.D.F.	PRESSURE TREATED DOUGLAS FIR		

LEGEND AND SYMBOLS

- 6 / A6 — TYP. NOTE — DETAIL NUMBER; DETAIL DESCRIPTION; SHEET NUMBER
- 5 / A5 — SECTION LETTER OR NUMBER; SHEET NUMBER
- 8 / A3 — ELEVATION NUMBER; SHEET NUMBER
- 1 / A — GRID DESIGNATION
- COLUMN CENTERLINE
- CENTER LINE
- PROPERTY LINE
- ELEV. — FLOOR ELEVATION OR WORK POINT
- 101.5' — SPOT ELEVATION
- (N) AREA DRAIN
- (N) ROOF DRAIN
- (N) ROOF VENT (SIZE VARIES)
- (N) RAINWATER LEADER
- MATCH LINE
- 5 / A6 — AREA ENLARGED; PLAN NUMBER; SHEET NUMBER
- 2 — REVISION NUMBER; AREA REVISED

AREA MAP

SCOPE OF WORK

PHASE I (PER SPECIFICATION SECTION 00800 SUPPLEMENTARY CONDITIONS)

EXTERIOR:

DEGLAZING OF SPANDREL PANELS AND INSPECTION OF EDGE OF REMOVED GLASS FOR DEFECTS. REINSTALLATION OF SPANDREL PANELS WITH NEW INTERIOR HOOK LIP GASKETS AND EXTERIOR HEADLESS WEDGE GASKETS. WET SEAL FRAME TO GLASS. REPLACEMENT OR REINSTALLATION OF ANY DAMAGED OR SHIFTED FIRESAFING. INSTALL TEMPORARY SHIMS TO HOLD EXISTING INSULATION A MINIMUM OF 1" AWAY FROM THE COATED FACE OF SPANDREL GLASS. RFI #6 1

PHASE II 2

REGARDING INTERIOR WORK, TENANTS ARE TO BE MOVED ONLY ONCE THROUGHOUT THE DURATION OF THE PROJECT. 2
REMOVAL OF EXISTING EXTERIOR AND INTERIOR GASKETS AT VISION GLASS UNITS. INSTALLATION OF NEW HEADLESS WEDGE WITH SEALANT. REAPPLICATION OF SEALANT AT THE PRECAST CONCRETE PANEL JOINTS AND EXPOSED SCREW FASTENER PENETRATIONS. NEW SEALANT AND BACKER ROD AROUND PUNCHED WINDOW FRAMES TO PRE-CAST. INSTALLATION OF NEW CUSTOM FORMED SILICONE BOOTS AT THE VERTICAL SPLICE JOINTS AND CAPS AT THE END OF MULLIONS. EPOXY INJECTION AT EXISTING CRACKS IN THE PRECAST CONCRETE PANELS. REAPPLICATION OF SEALANT AROUND THE STOREFRONT GLAZING SYSTEM AT THE FIRST AND SECOND FLOORS. REPLACEMENT OF EXISTING INSULATION AT SPANDREL GLASS WITH NEW INSULATION AND NEW PERMANENT SPACERS TO KEEP INSULATION AWAY FROM FACE OF GLASS. INSTALLATION OF NEW SPANDREL LITES AT TEMPORARILY PLUGGED LOCATIONS FROM PHASE I. REPLACEMENT OF ANY EXISTING DAMAGED OR STAINED CEILING TILES OR GYPSUM BOARD. DISASSEMBLY OR MOVING OF ALL FURNITURE AND EQUIPMENT AS NECESSARY TO PERFORM WORK. COORDINATION OF IMPACT WITH TENANT AND CLIENT. 2
1

PHASE III

REPLACEMENT OF EXISTING DECK SYSTEM AT THE TWENTY THIRD FLOOR ON ALL FOUR ELEVATIONS. REPLACEMENT OF EXISTING DECK SYSTEM AT THE GARAGE ROOF AND THIRD FLOOR INTERFACE AT THE SOUTH AND WEST ELEVATIONS. DEMOLITION AND DISPOSAL OF (E) TREES AND PLANTERS ON 23RD FLOOR DECKS. 2

ADDENDUM #2.

DRAWING INDEX

ARCHITECTURAL

OFFICE OF STATE FIRE MARSHAL APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.
Reviewed by: 5/3/06

GENERAL NOTES

1. THE CONTRACTOR SHALL VERIFY ALL EXISTING FIELD CONDITIONS, DIMENSIONS, AND QUANTITIES. EXACT QUANTITIES, LOCATIONS, AND MEASUREMENTS ARE THE RESPONSIBILITY OF THE CONTRACTOR.
2. THE CONTRACTOR SHALL VERIFY EXISTING CONDITIONS AND REPORT TO THE ARCHITECT FOR ANY UNFORESEEN CONDITIONS NOT MENTIONED IN THE SPECIFICATIONS AND NOT INDICATED ON THE DRAWINGS. APPLYING WORK ON EXISTING CONDITIONS MEANS THAT THE CONTRACTOR HAS VERIFIED AND ACCEPTED THE CONDITIONS.
3. THE BUILDING PERIMETER IS SHOWN FOR INFORMATION ONLY AND MAY VARY FROM THE DRAWINGS AS THERE MAY HAVE BEEN RENOVATION IN THE BUILDING.
4. ANY CONDITIONS DETECTED DURING CONSTRUCTION OTHER THAN NOTED ON THE CONSTRUCTION DOCUMENTS SHALL BE REPORTED TO THE ARCHITECT. THE CONTRACTOR SHALL BE RESPONSIBLE FOR INFORMING THE ARCHITECT OF THE PRESENCE OF ANY HAZARDOUS MATERIALS.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL REQUIRED PERMITS FOR THE SCOPE OF WORK OF THE PROJECT AND ALL OTHER REQUIRED APPROVALS PRIOR TO COMMENCEMENT OF WORK.

450 N STREET

BOARD OF EQUALIZATION
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Seal:
LICENSED ARCHITECT JEFF DRAA #17977 7/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MECHANICAL M19582 EXP. 9/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

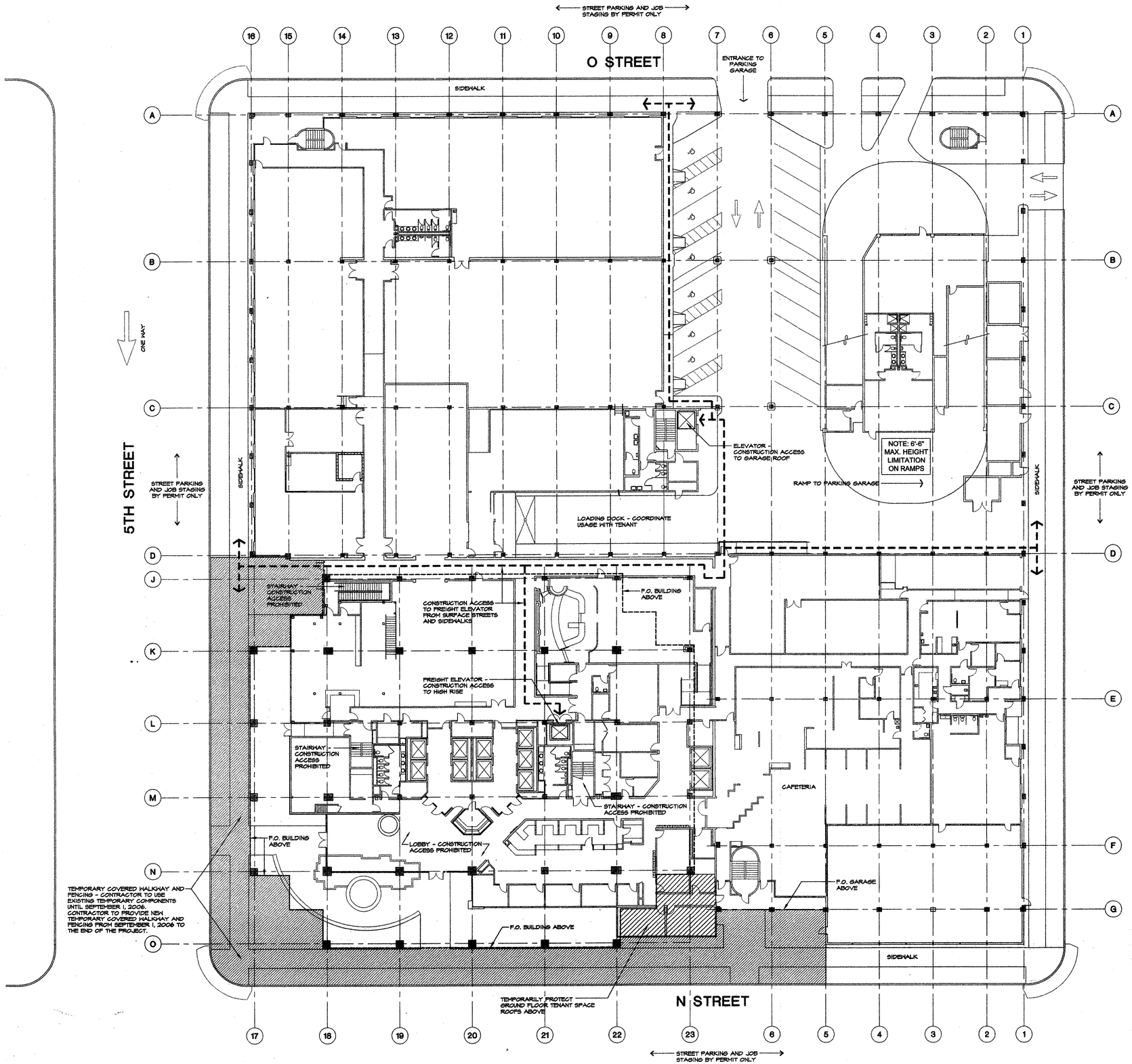
NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #1	04.03.06
	ADDENDUM #2	04.10.06
	CONSTRUCTION SET	04.19.06
	BULLETIN #1	05.03.06

Sheet Title:
TITLE SHEET

Scale:	AS NOTED
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A001

Apr 19, 2006 - 1:45pm 05155 - A001



OFFICE OF STATE FIRE MARSHAL
APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by: _____ 5/31/06

450 N STREET

BOARD OF EQUALIZATION
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Seal:

LICENSED ARCHITECT
ALFRED JEFFRIES
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-HSIU CHEN
M 19582
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

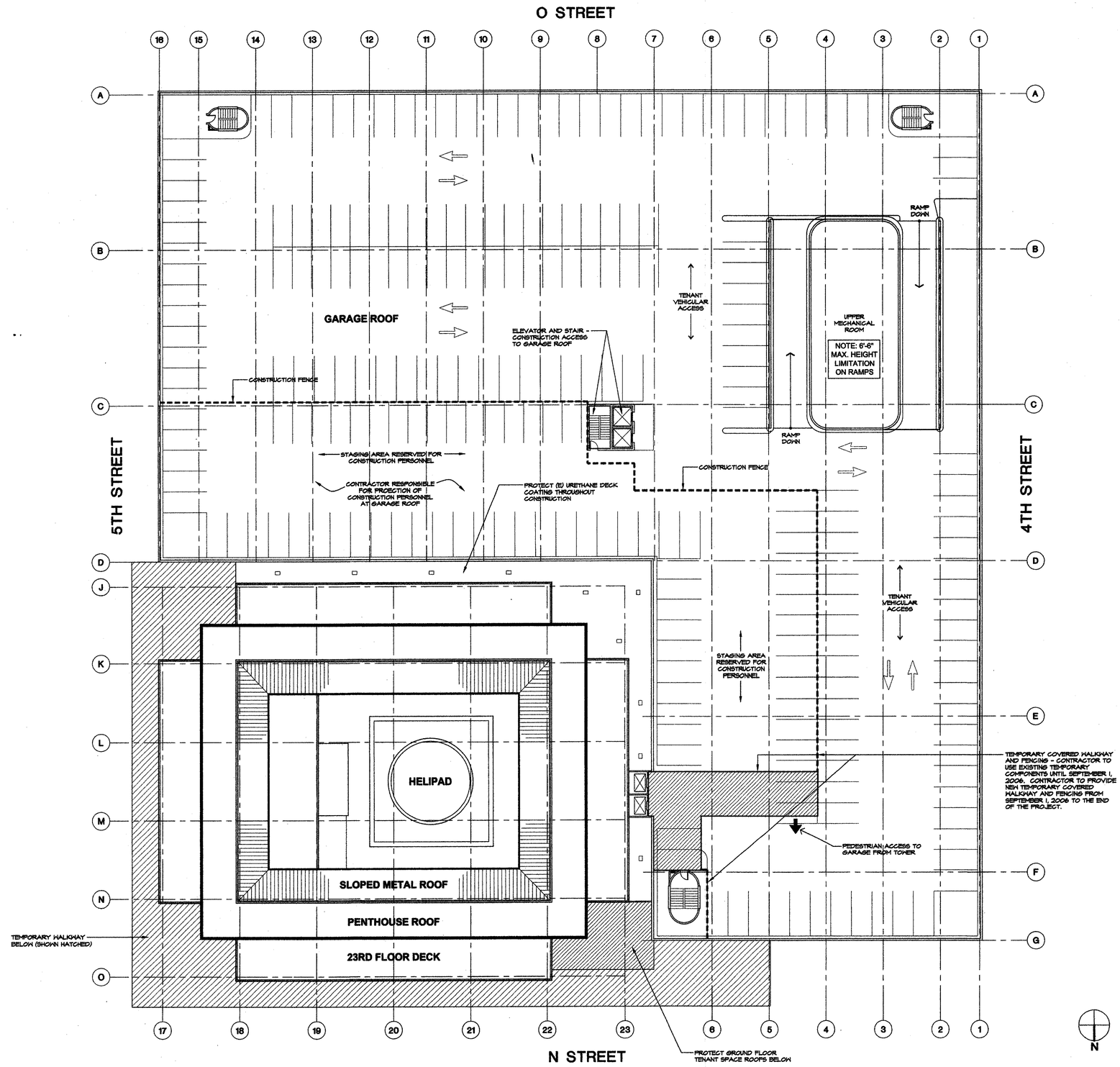
Sheet Title:

SITE PLAN

Scale:	1" = 20'
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A101

Apr 19, 2006 - 11:49am 05155 - A101



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Reviewed by: 5/5/06

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LICENSED ARCHITECT YI-TSO JEFF CHEN #17977 RENEWAL DATE 8/31/07 STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MENG-HSIU CHEN M19582 EXP. 8/31/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

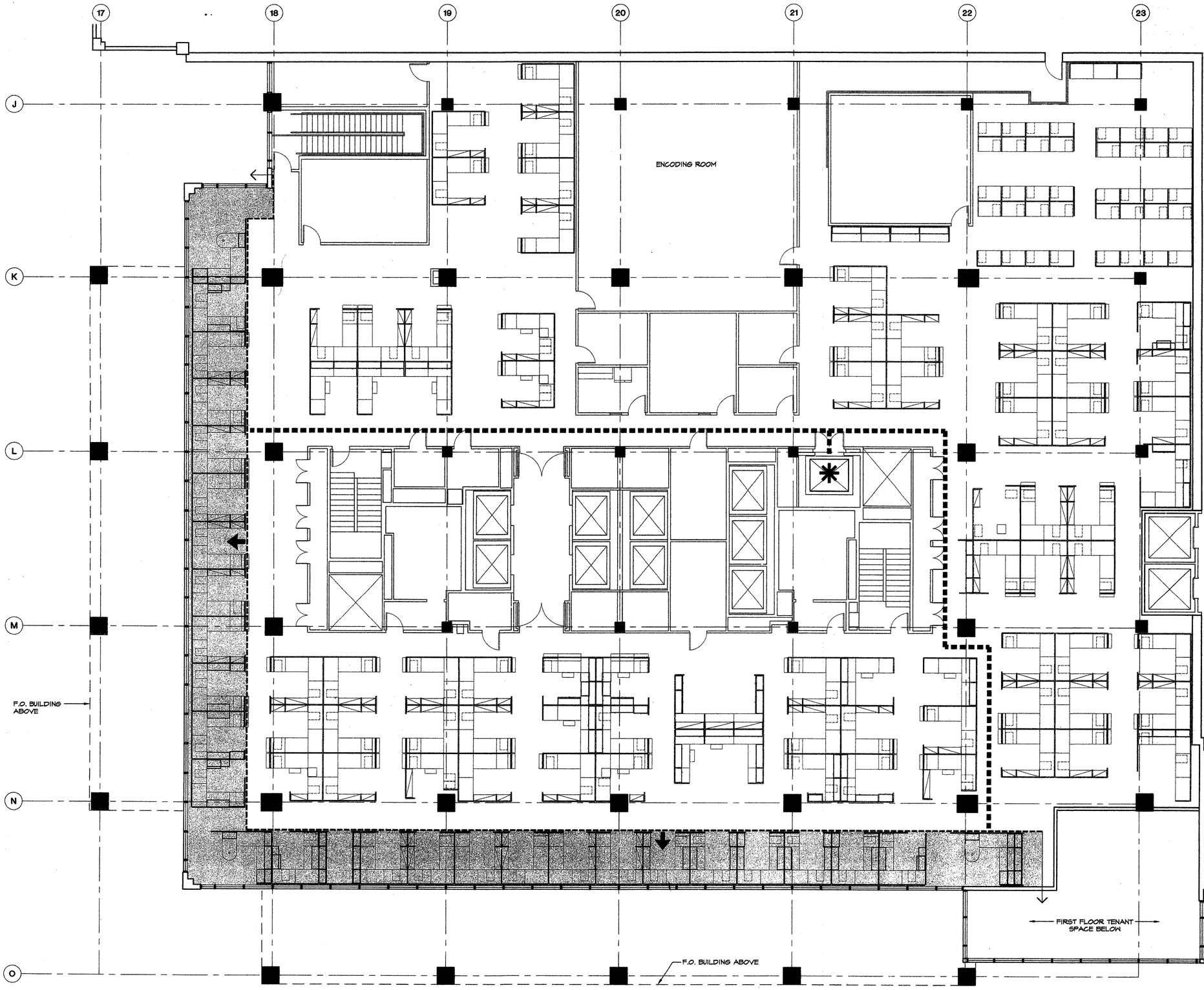
Sheet Title:

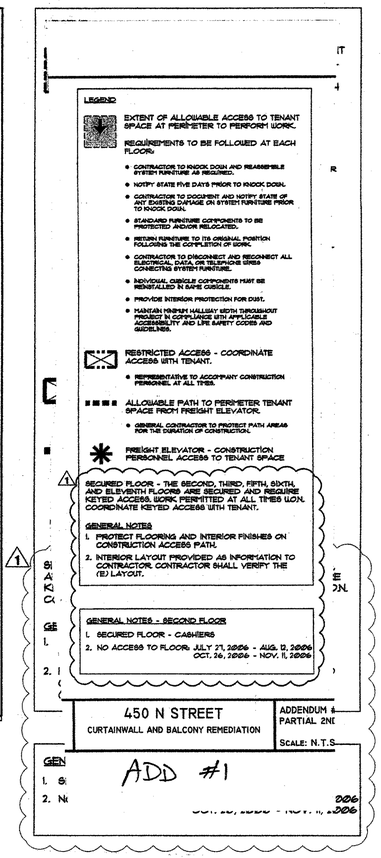
SITE PLAN - COMPOSITE ROOF PLAN

Scale:	1" = 20'
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A102

Apr 19, 2006 - 11:49am 05155 - A102





INT WORK COMPLETE 3/16/07
ALL OK
Doris Hallstead
Mary

OFFICE OF STATE FIRE MARSHAL
APPROVED
Approval of this plan **does not authorize or approve any omission or deviation from** applicable regulations. **Final approval is subject** to field inspection. One set of approved plans shall be available on the project site at all times.
Reviewed by: 5/3/07

450 N STREET

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Seal:

LICENSED ARCHITECT
YUSO JEFF CHEN
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MECHANICAL
YUSO JEFF CHEN
No. M 19582
EXP. 9/30/07
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #1	04.03.06
	CONSTRUCTION SET	04.19.06

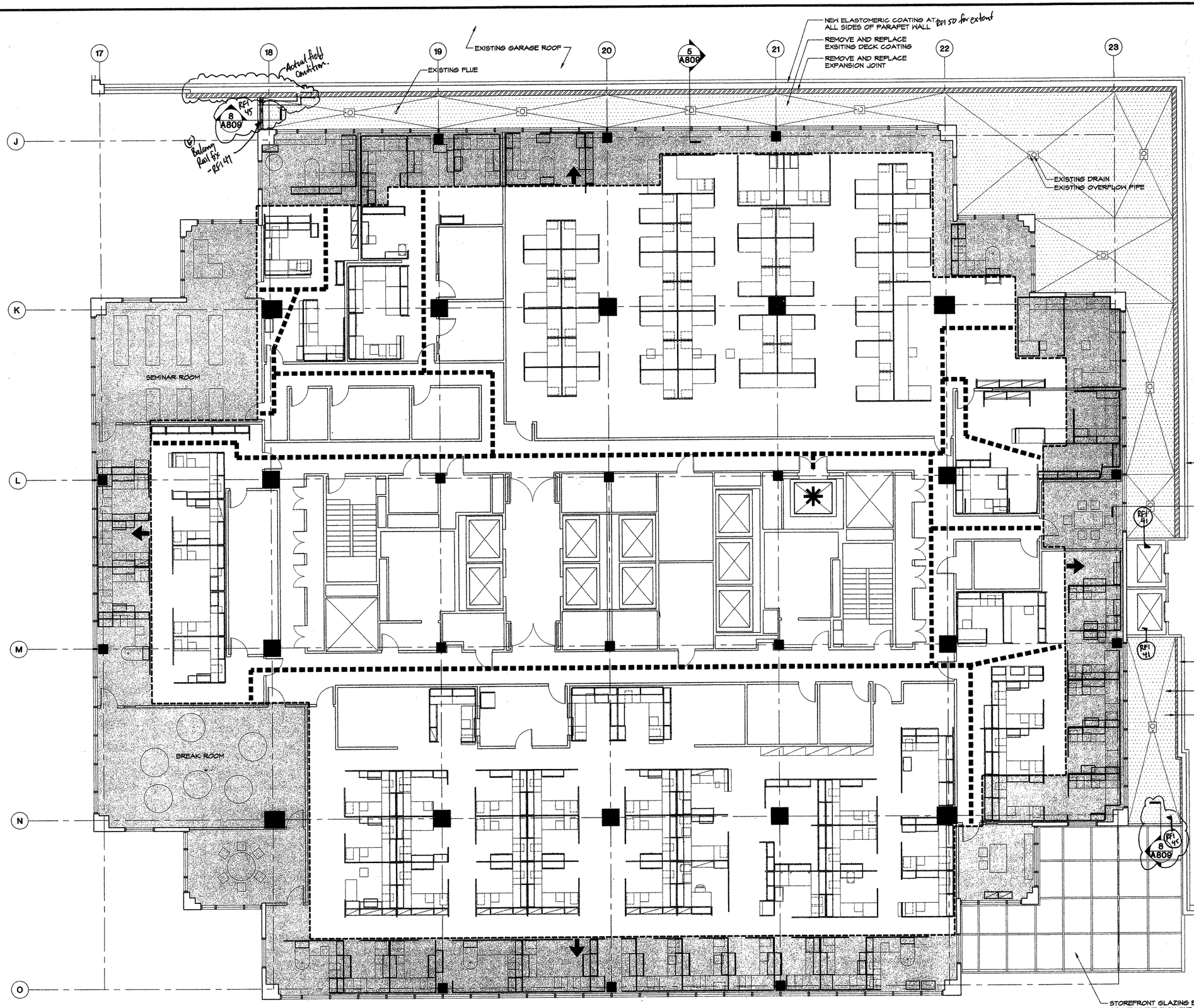
Sheet Title:

SECOND FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A202

Apr 19, 2006 - 4:55pm 05155 - A202



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.
3. SECURED FLOOR - HUMAN RESOURCES

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Developed by [signature] 3/23/06

450 N STREET

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LICENSED ARCHITECT 11750 JEFF CHEN #17971 6/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER JEFFREY S. HSU M13562 EXP. 8/31/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

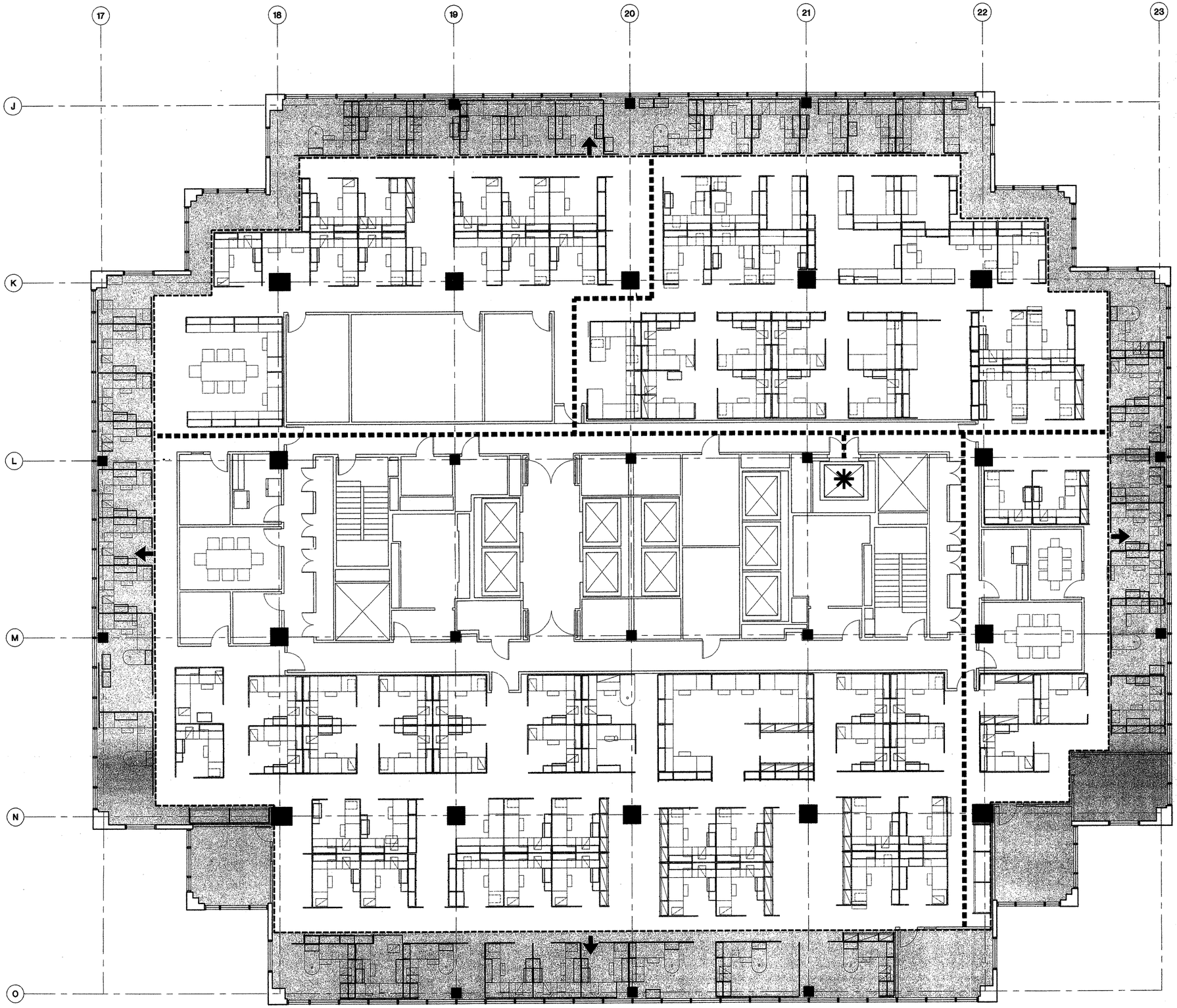
Sheet Title:

THIRD FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A203

Apr 19, 2006 - 11:50am 05155 - A203



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR WORK COMPLETE
NE - 3/8/07 - ALL OK
SW - 11/21/07 - ALL OK
David Fultonb
Dmag

N

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APPROVED
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Reviewed by: 3/3/06

450 N STREET

BOARD OF EQUALIZATION
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Mechanical & Life Safety Engineer:

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Seal:

LICENSED ARCHITECT TIMOTHY JEFFERS #17877 9/20/07 RENEWAL DATE STATE OF CALIFORNIA

PROFESSIONAL ENGINEER MECHANICAL M 13582 EXP. 8/31/07 STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

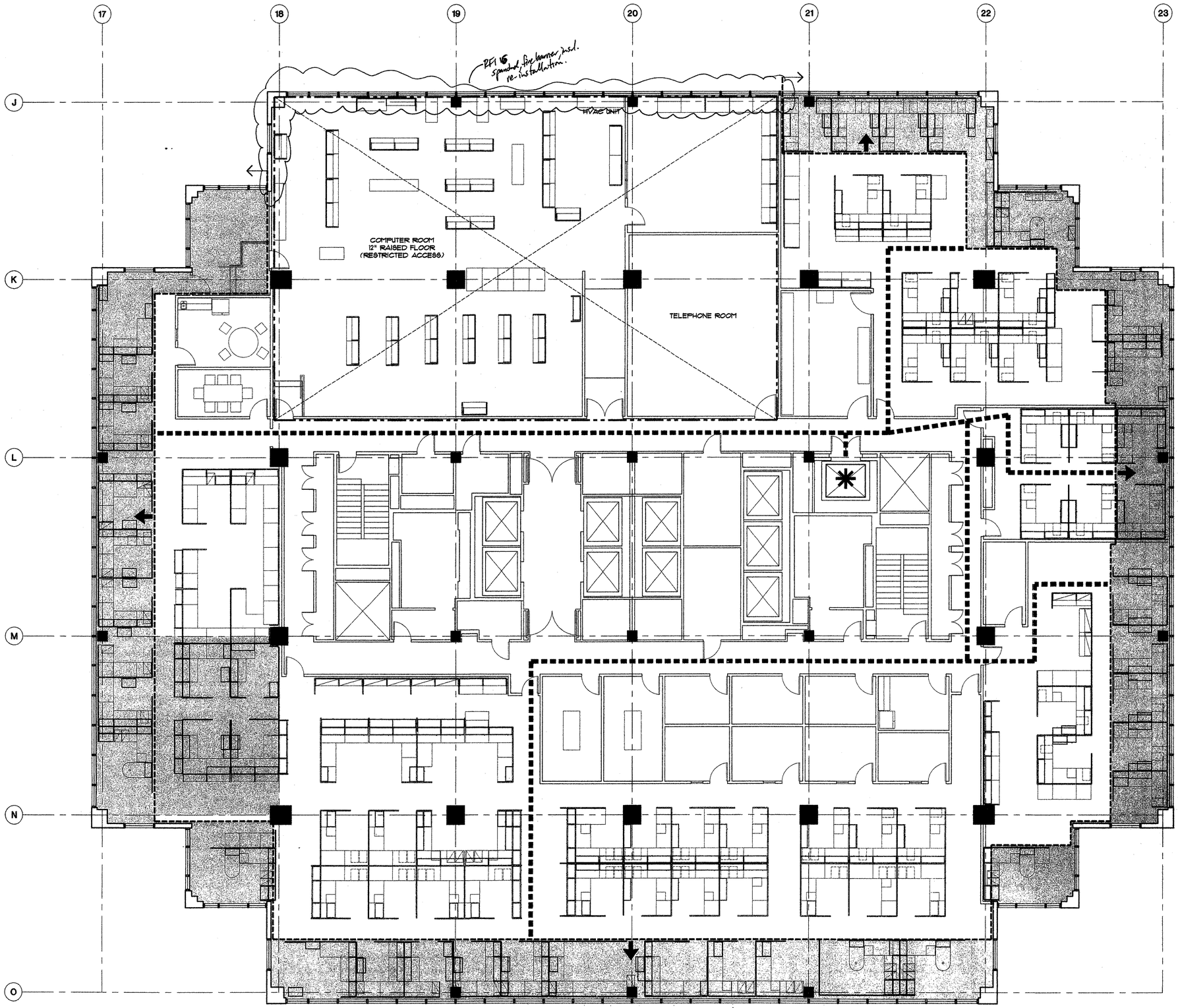
Sheet Title:

FOURTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	BG
Checked:	RR

A204

Apr 19, 2006 - 11:50am 05155 - A204



LEGEND

- EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.
3. SECURED FLOOR - TECHNICAL SERVICES RESTRICTED ACCESS - COMPUTER SERVER ROOM
4. OWNER IS RESPONSIBLE FOR MOVING AND REPLACING COMPUTER EQUIPMENT INSIDE OF COMPUTER ROOM IN ORDER FOR CONTRACTOR TO HAVE ACCESS TO PERIMETER WALLS. CONTRACTOR IS TO COORDINATE WITH OWNER FOR MOVING OF EQUIPMENT AND EXTENT OF REQUIRED WORK ACCESS SPACE. 2

INTERIOR WORK COMPLETE
SW - 1/24/07 - ALL OK
NE - 3/2/07 - ALL OK
David Fulton
Mayo

N

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APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by: 3/23/07

450 N STREET

BOARD OF EQUALIZATION
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Mechanical & Life Safety Engineer:

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Seal:

LICENSED ARCHITECT JEFFREY CHEN #17871 9/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MECHANICAL SIU CHEN M19682 EXP. 9/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #2	04.10.06
	CONSTRUCTION SET	04.19.06

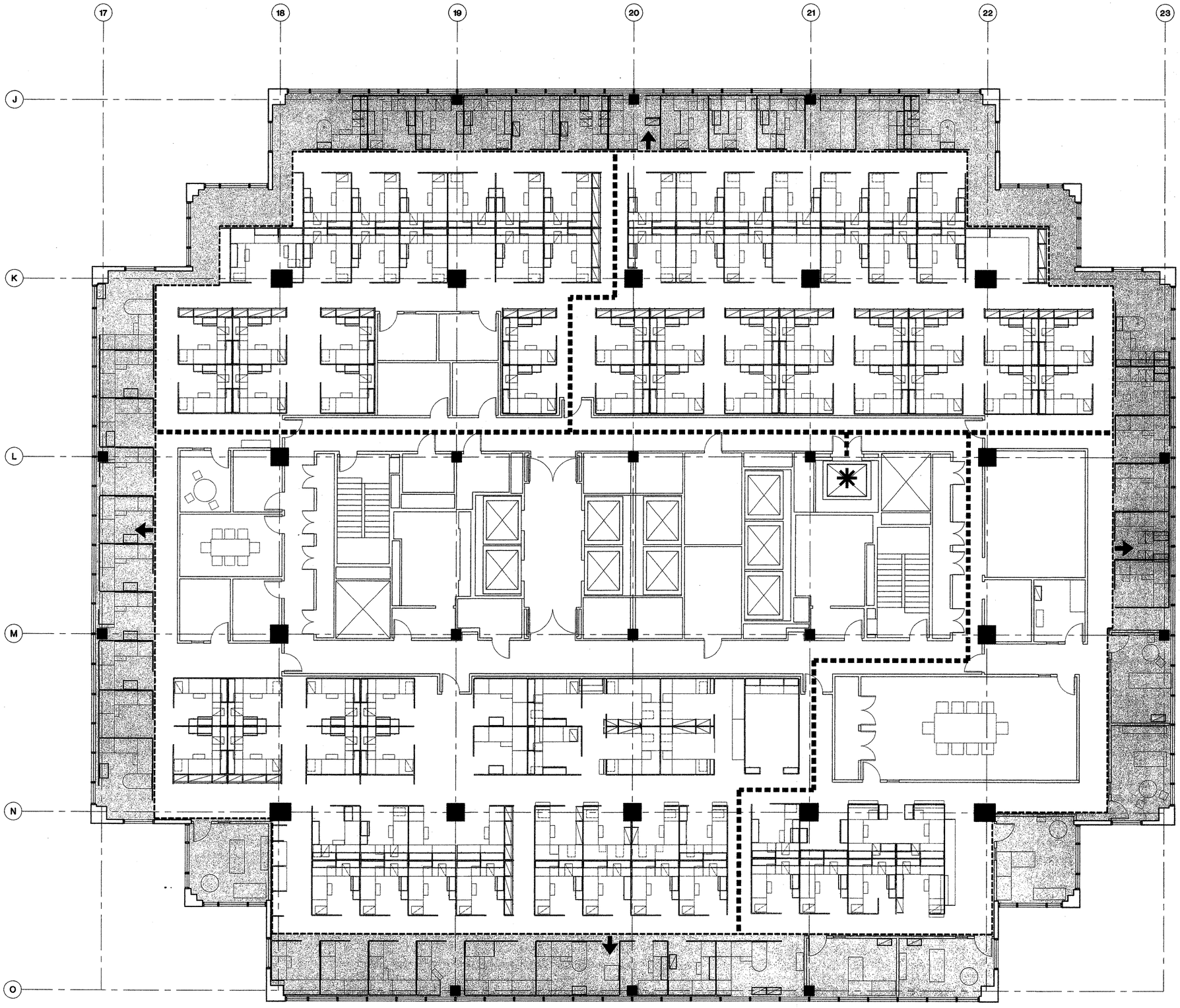
Sheet Title:

FIFTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A205

Apr 19, 2006 - 11:50am 05155 - A205



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.
3. SECURED FLOOR - TECHNOLOGY SERVICES

INTERIOR WORK COMPLETE
NE - 2/28/07 - ALL OK
SW - 1/18/07 - ALL OK

N

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Reviewed by _____ 8/5/07

450 N STREET

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Seal:

LICENSED ARCHITECT YI-TSO JEFF CHEN #17977 9/26/07 STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MEI-HSIU CHEN MHC M13582 EXP. 8/31/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

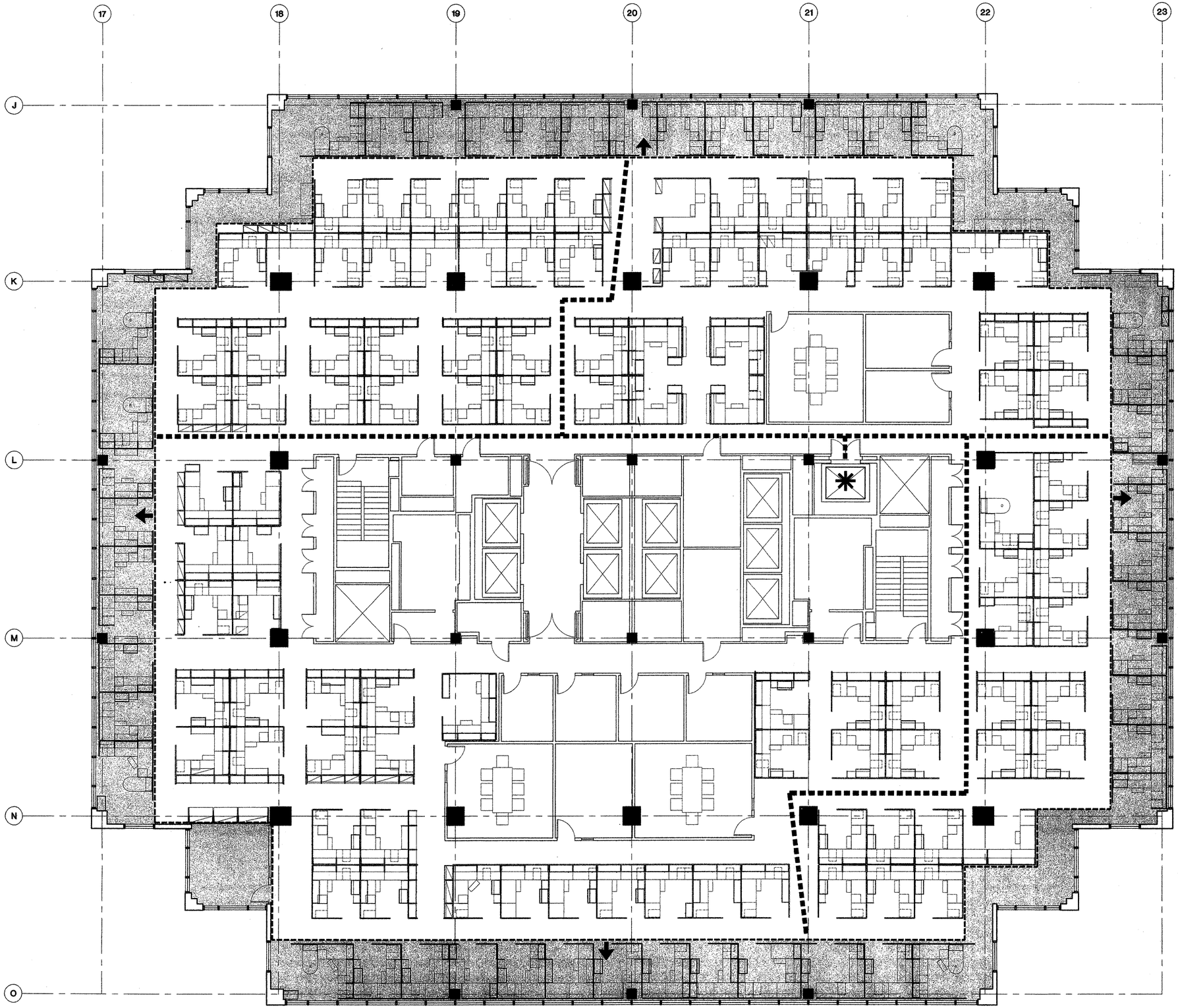
Sheet Title:

SIXTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A206

Apr 19, 2006 - 11:51am 05155 - A206



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR INSPECTED 2/27/07 NE
HCA ALL CASKETS OK

INTERIOR WORK COMPLETE - SW
ALL OK 1/16/07

N

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APPROVED
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Reviewed by: 5/15/07

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Seal:

LICENSED ARCHITECT
YI-TSO JEFF CHEN
#17977
4/30/07
RENEWAL DATE
STATE OF CALIFORNIA

4/4/07
07
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

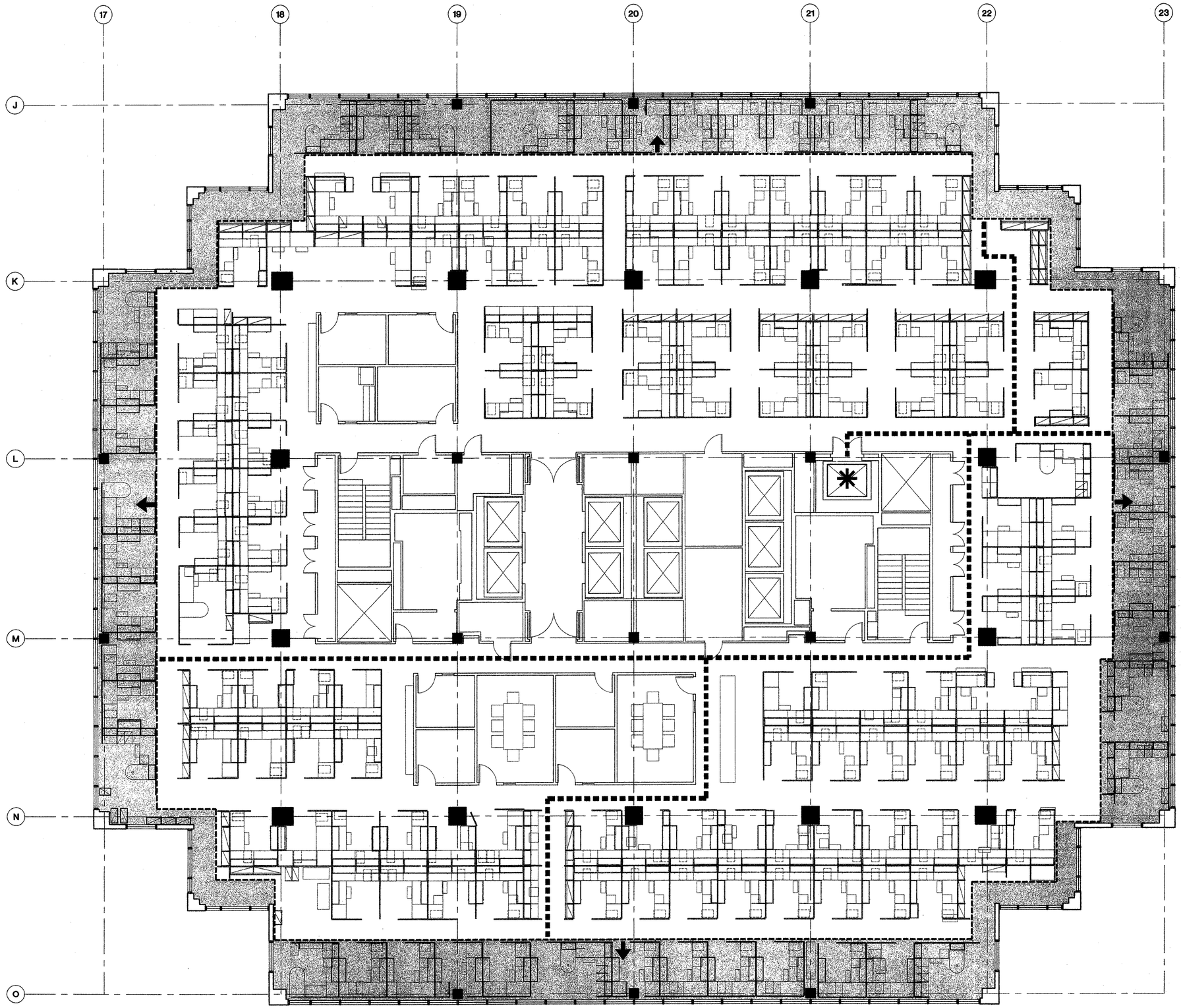
Sheet Title:

SEVENTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A207

Apr 19, 2006 - 11:51am 05155 - A207



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

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2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR WORK COMPLETE
DE - 2/20/07 ALL OK
SJ - 12/21/07 ALL OK

N

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Reviewed by: 5/5/06

450 N STREET

BOARD OF EQUALIZATION
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LICENSED ARCHITECT
M.1780 JEFF CHEN
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-HSIU CHEN
M13582
EXP. 8/31/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

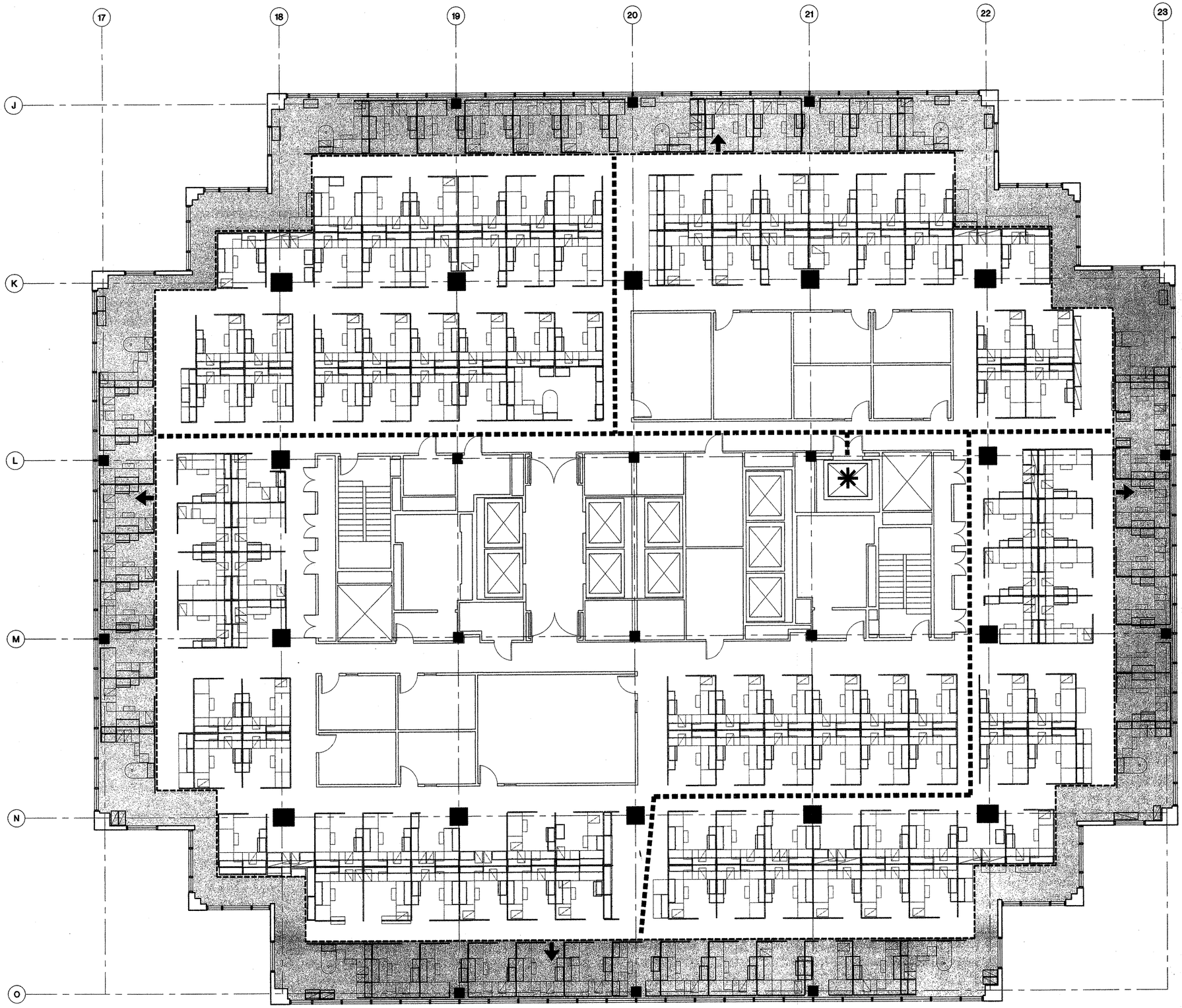
Sheet Title:

EIGHTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A208

Apr 19, 2006 - 11:51am 05155 - A208



LEGEND

- EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

N&E ELEVATIONS INTERIOR WORK
ALL OK 2/14/07 (MCA)

INTERIOR WORK ON SU - ALL OK
12/19/07

N

OFFICE OF STATE FIRE MARSHAL
APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by: 5/3/07

450 N STREET

BOARD OF EQUALIZATION
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LICENSED ARCHITECT
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-REID CHEN
M13592
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

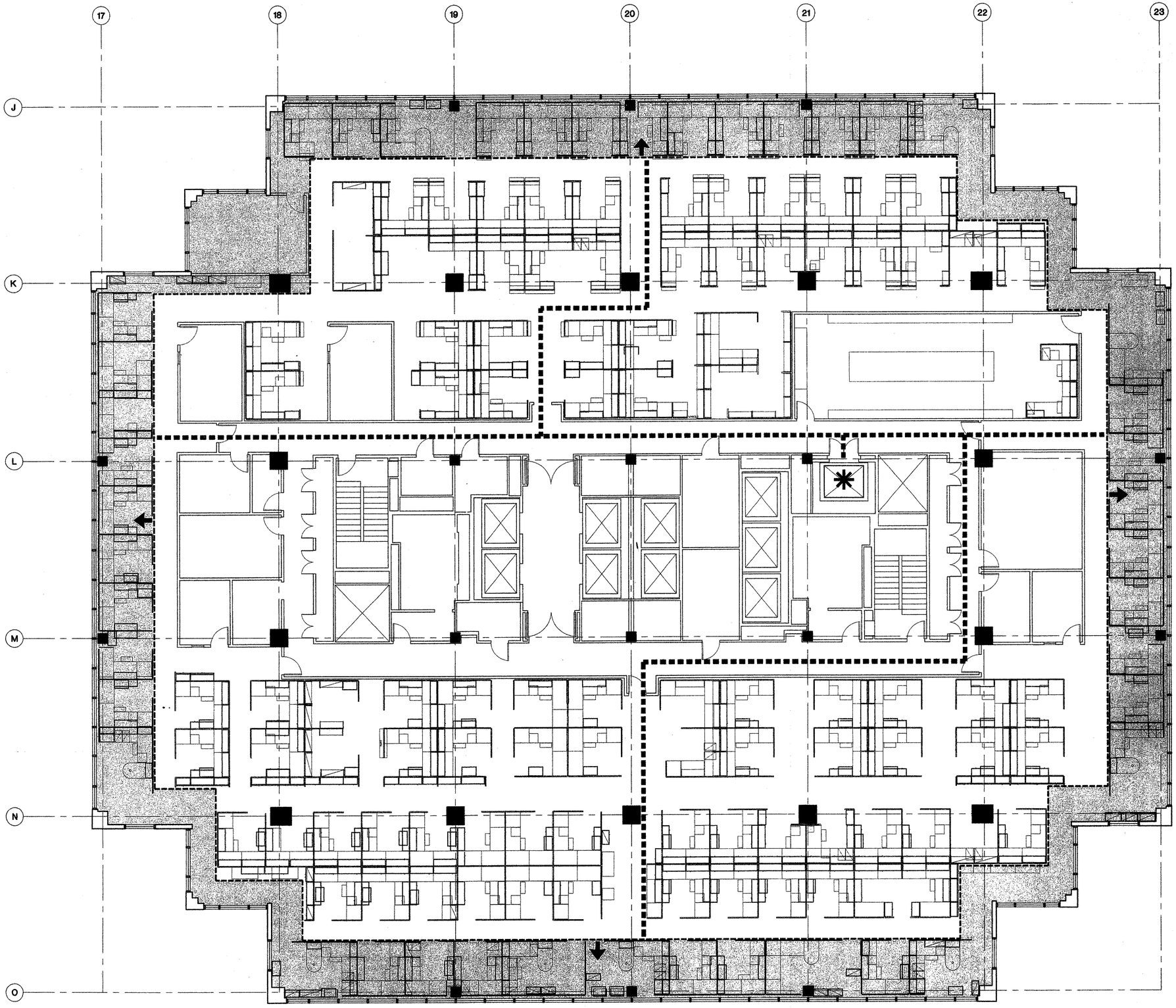
Sheet Title:

NINTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A209

Apr 19, 2006 - 11:52am 05155 - A209



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR WORK COMPLETE
WE - 10/8/07 - ALL OK

SW - 12/13/07 - ALL OK

N

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APPROVED
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Reviewed by: 5/31/07

450 N STREET

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Seal:

LICENSED ARCHITECT
JEFF CHEN
C-17977
EXP. 8/2007
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MARK SIU CHEN
M-19562
EXP. 8/2007
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

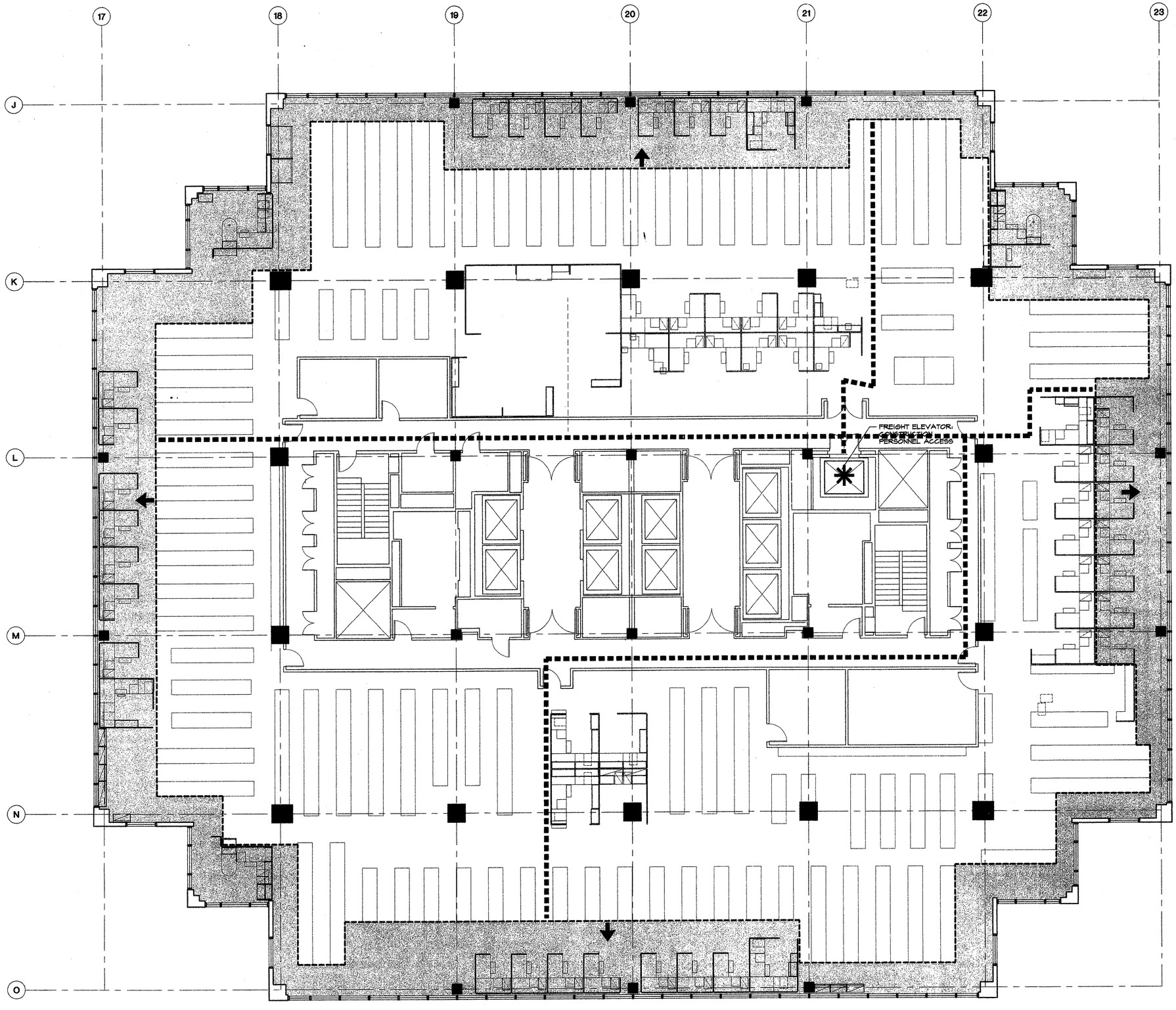
Sheet Title:

TENTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A210

Apr 19, 2006 - 11:52am 05155 - A210



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.
3. SECURED FLOOR - TAX PAYER RECORDS

INTERIOR (ok) !
NLE ELEVATIONS ~~INCOMPLETE~~
GASKETS OK (ok) 2/2/07
ALL WORK OK

SW - ALL OK 12/11/06
David Hultstrand
Mary

N

OFFICE OF STATE FIRE MARSHAL
APPROVED
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Reviewed by: 5/5/06

450 N STREET

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LICENSED ARCHITECT WEI-TSO JEFF CHEN #17977 4/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED DEPUTY COMMUNITY ENGINEER MENG-HSIU CHEN M19582 EXP. 6/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

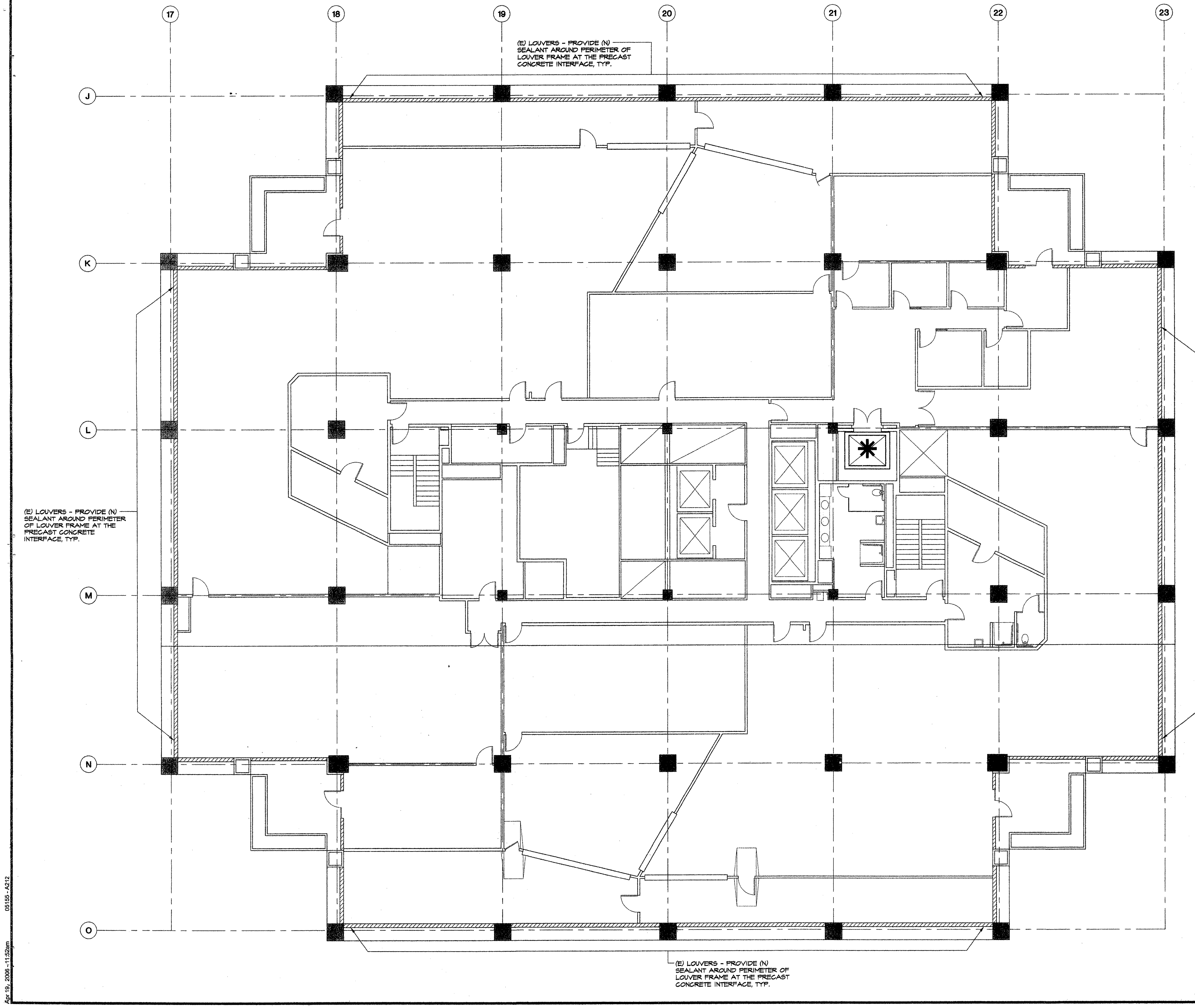
Sheet Title:

ELEVENTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A211

Apr 19, 2006 - 11:52am 05155 - A211



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A2Ø2 FOR ADDITIONAL INFORMATION.

RESTRCITED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A2Ø2 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A2Ø2 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.
2. MECHANICAL FLOOR - PERMIETER ACCESSIBLE TO CONSTRUCTION PERSONNEL
3. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

LOUVER/PRECAST CAULKING. ALL OK

OFFICE OF STATE FIRE MARSHAL
APPROVED
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Reviewed by: 5/3/06

450 N STREET

BOARD OF EQUALIZATION
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LICENSED ARCHITECT
YI-TSO JEFF CHEN
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
M 31032
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

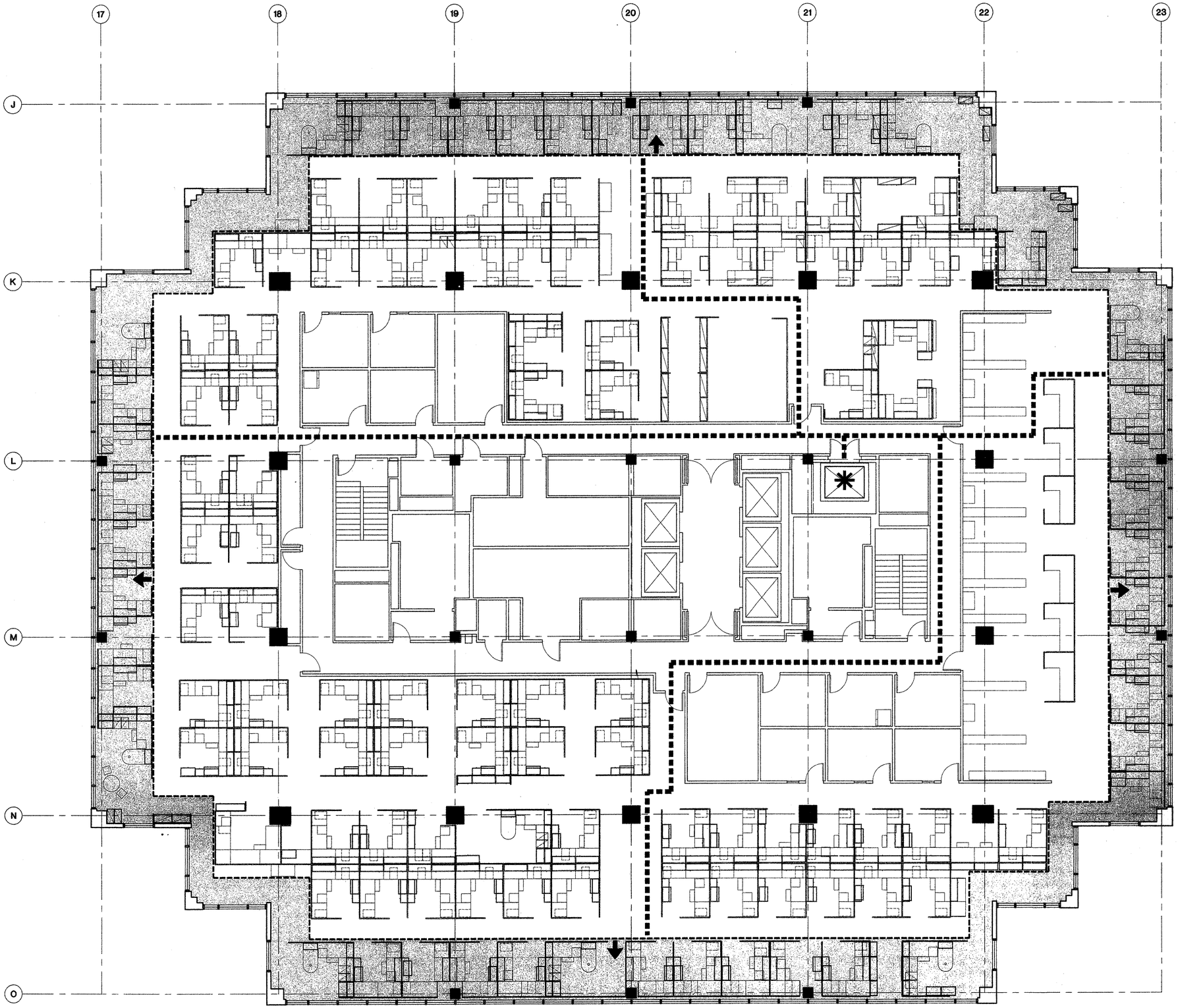
Sheet Title:

TWELFTH FLOOR MECHANICAL PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A212

05155 - A212
Apr 19, 2006 - 11:52am



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR WORK COMPLETE
SJ - 10/26/06 - ALL OK
NE - 12/5/06 - ALL OK

N

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APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to ... inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by: 8/3/06

450 N STREET

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Seal:

LICENSED ARCHITECT YI-TSO JEFF CHEN #17077 9/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MENG-HSIU CHEN M19582 EXP. 8/31/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

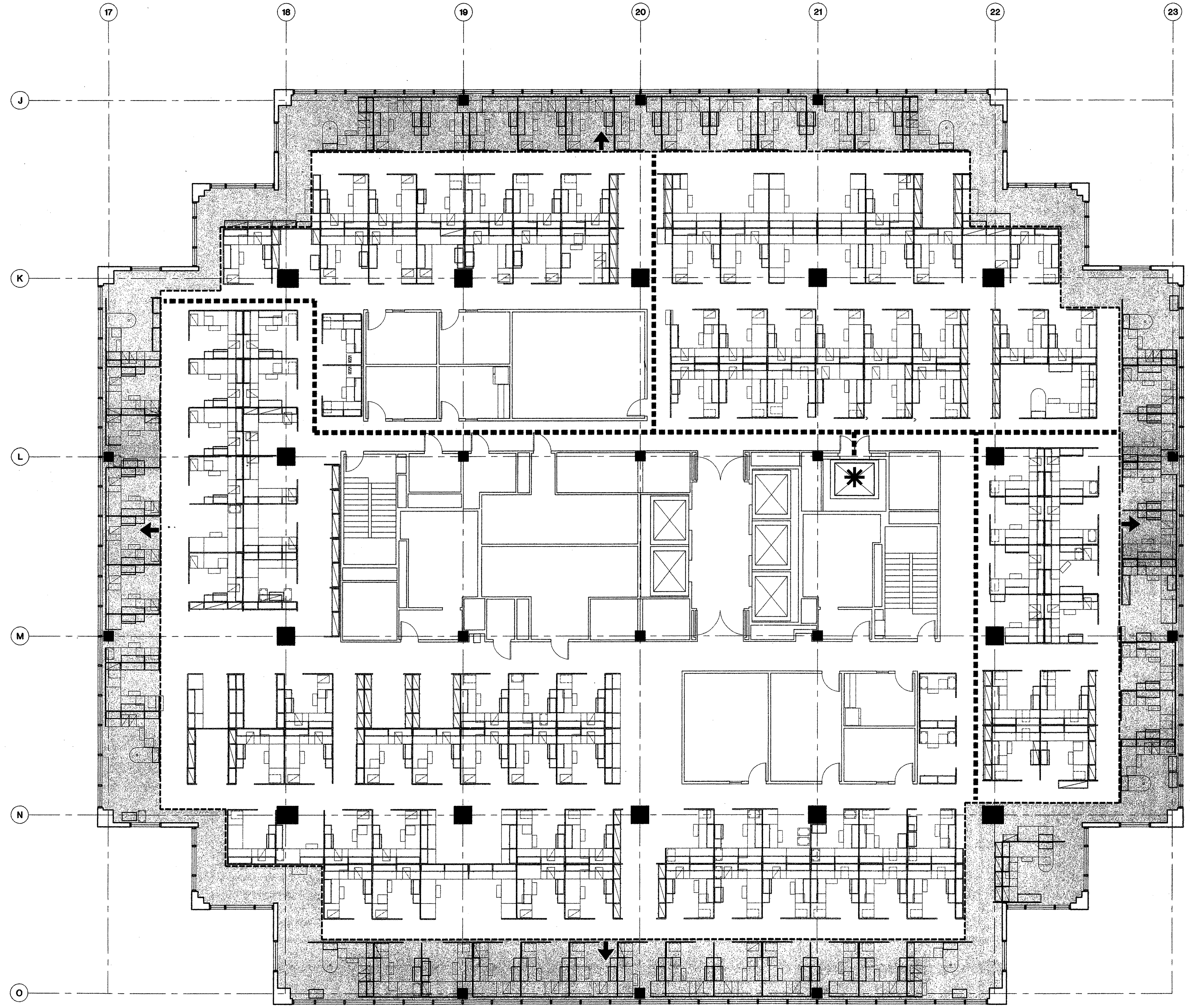
Sheet Title:

FOURTEENTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A214

Apr 19, 2006 - 11:52am 05155 - A214



LEGEND

- EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A2Ø2 FOR ADDITIONAL INFORMATION.
- RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A2Ø2 FOR ADDITIONAL INFORMATION.
- ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A2Ø2 FOR ADDITIONAL INFORMATION.
- * FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR WORK COMPLETE
SU - 10/20/06 - ALL OK
NE - 12/1/06 - ALL OK

N

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Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by: 5/3/06

450 N STREET

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Mechanical & Life Safety Engineer:

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LICENSED ARCHITECT
YI-HSO JEFF CHEN
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-HSIU CHEN
M19582
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

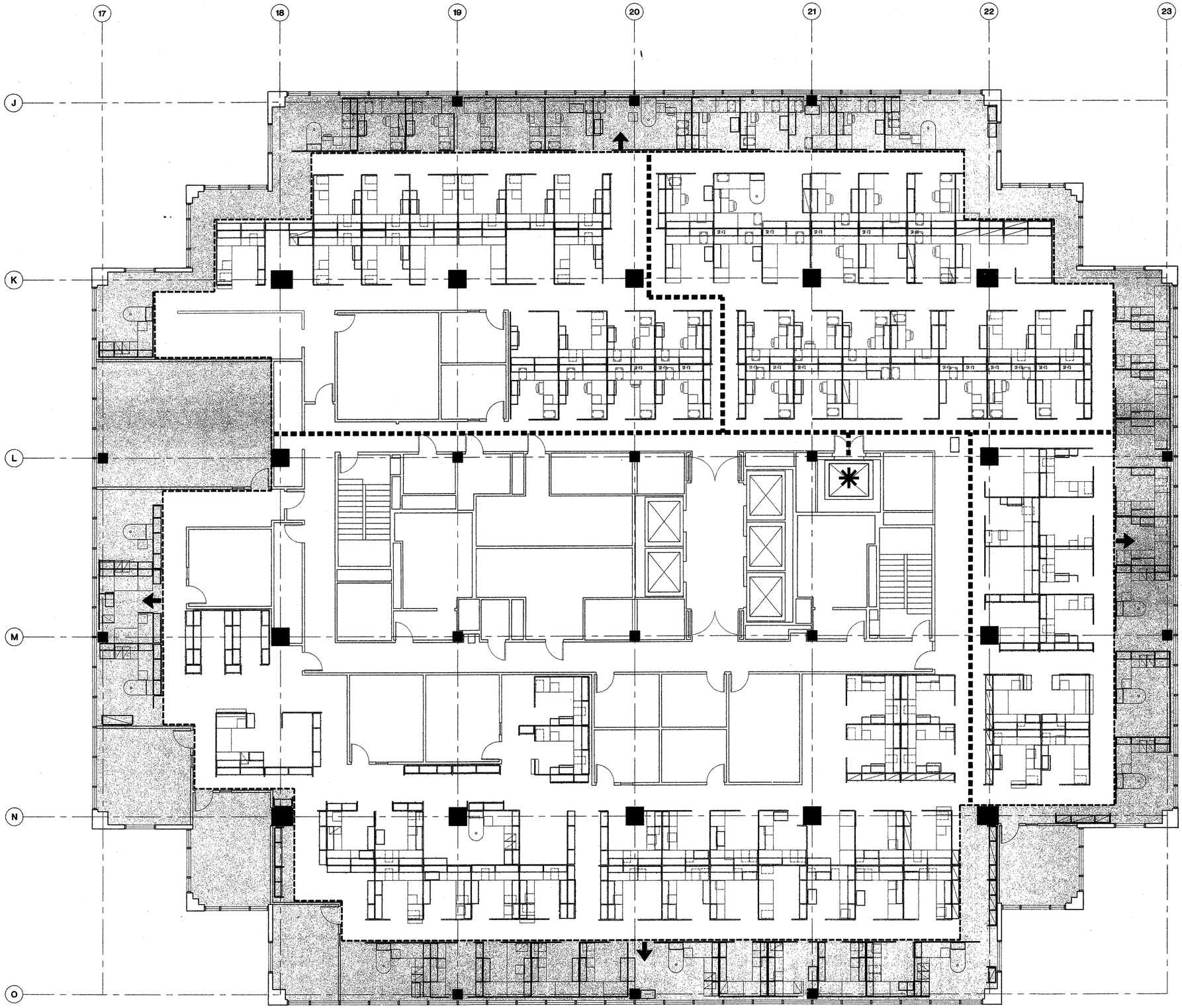
Sheet Title:

FIFTEENTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A215

05155 - A215
Apr 19, 2006 - 11:53am



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR WORK COMPLETE
SW - 10/18/06 - ALL OK
NE - 11/27/06 - ALL OK

N

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Reviewed by: 3/5/07

Apr 19, 2006 - 11:53am 05155 - A216

450 N STREET

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LICENSED ARCHITECT
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#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MECHANICAL
M 19582
EXP. 9/30/07
STATE OF CALIFORNIA

CONSTRUCTION SET

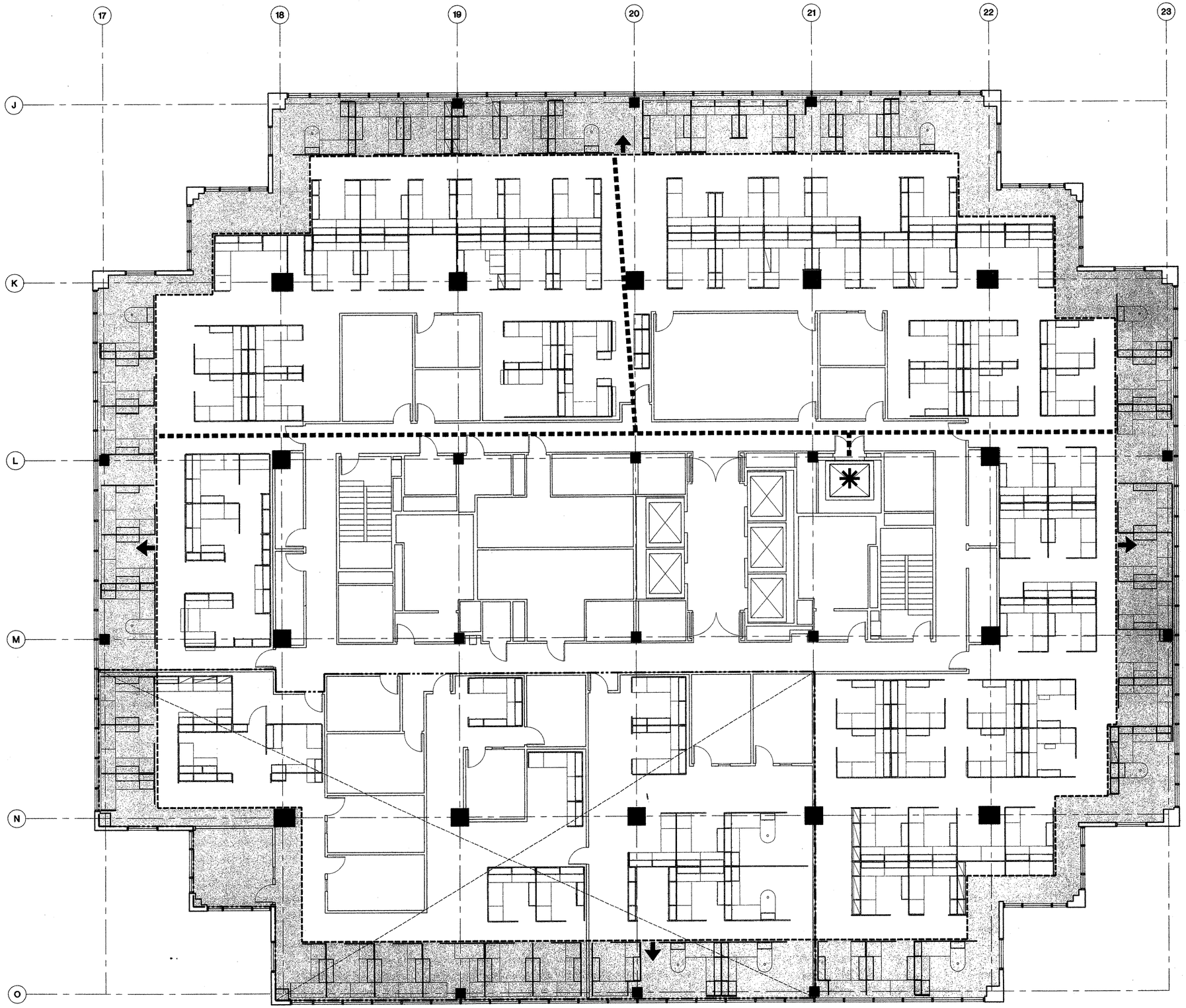
NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

Sheet Title:

SIXTEENTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A216



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.
3. SECURED FLOOR - INTERNAL SECURITY

INTERIOR WORK COMPLETE
SW - 10/12/06 - ALL OK

NE - 11/21/07 - ALL OK
David Walters
Mayo

N

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APPROVED
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5/5/06

450 N STREET

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FAX (415) 512-7120

Seal:

LICENSED ARCHITECT
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C-17977
9/30/10
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-HSIEH CHEN
M 13562
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #1	04.03.06
	CONSTRUCTION SET	04.19.06

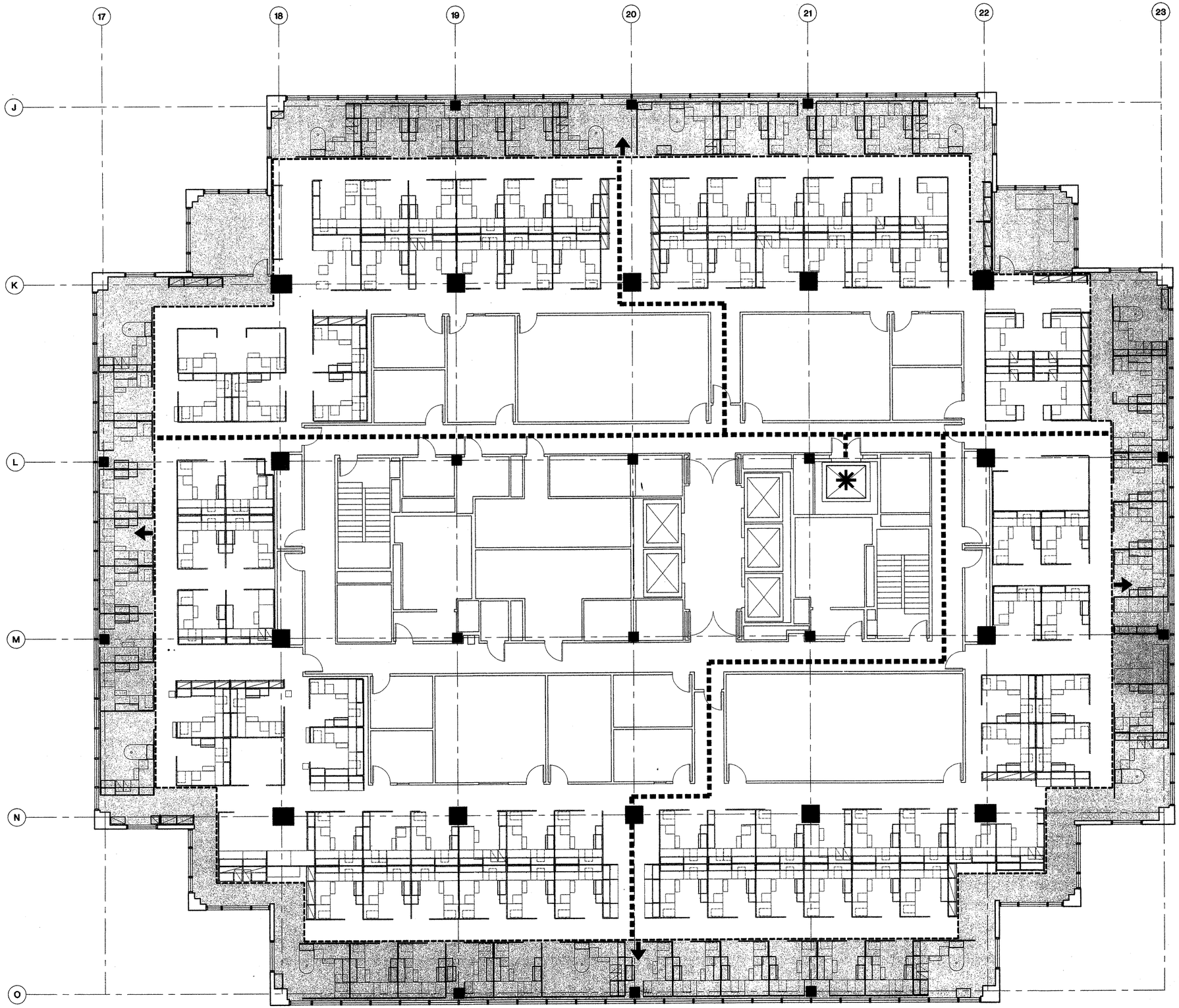
Sheet Title:

SEVENTEENTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A217

Apr 19, 2006 - 6:14pm 05155 - A217



LEGEND

- EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR WORK COMPLETE
SW - 10/10/06 - ALL OK

NE - 11/15/06 - ALL OK
David Holland
Dragg

N

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Stephen Hu 3/3/06

450 N STREET

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Seal:

LICENSED ARCHITECT
JEFF CHEN
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-HSIU CHEN
M13582
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

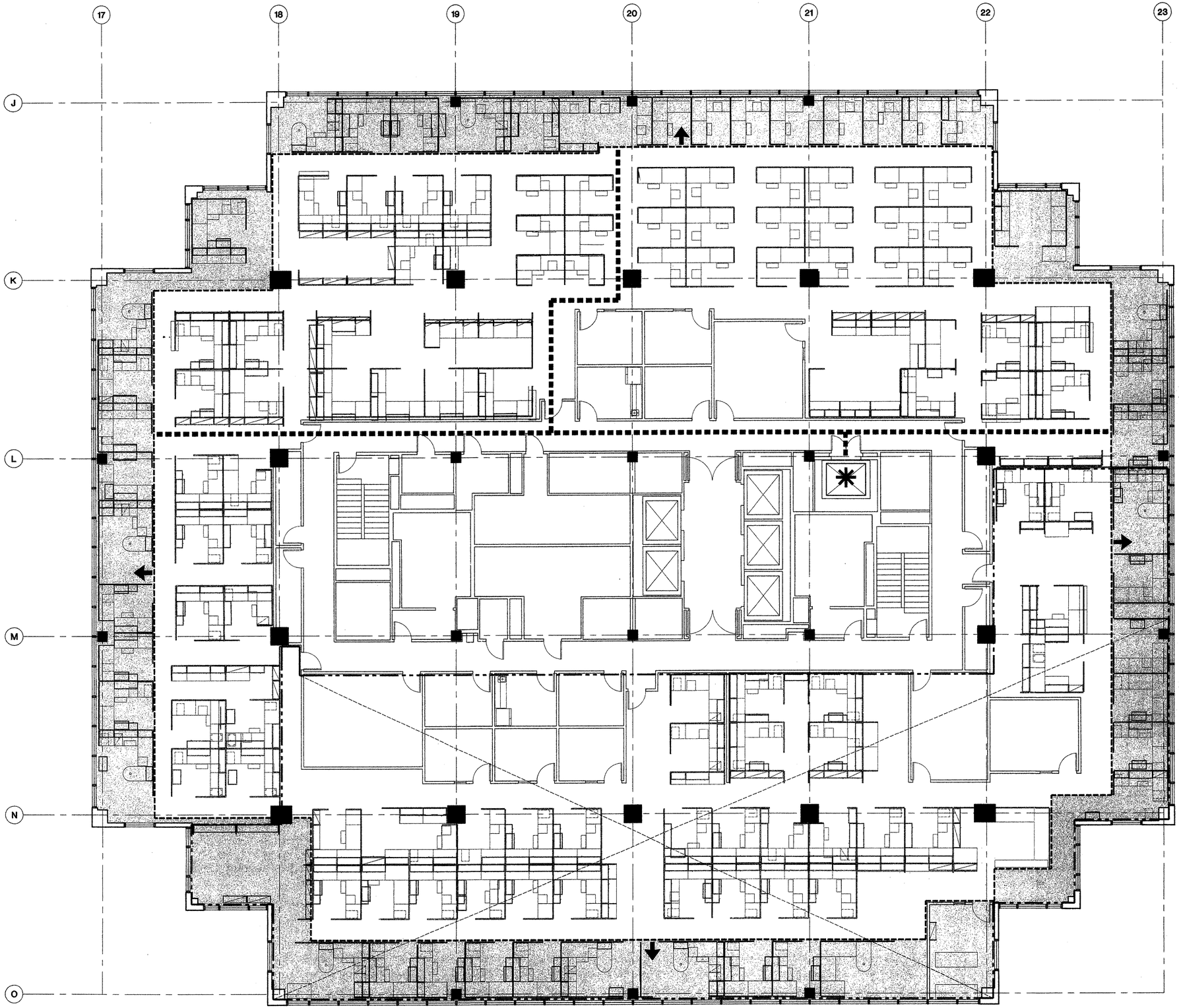
Sheet Title:

EIGHTEENTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A218

Apr 19, 2006 - 11:53am 05155 - A218



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.
3. SECURED FLOOR / RESTRICTED ACCESS - INVESTIGATIONS

INTERIOR WORK COMPLETE
SW - 10/4/06 - ALL OK
ME - 11/13/06 - ALL OK

OFFICE OF STATE FIRE MARSHAL
APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.
Reviewed by:

N

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

CLIENT:

State of California
Department of General Services
Real Estate Services Division
707 Third Street Suite 3-305
West Sacramento, CA 95605
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Mechanical & Life Safety Engineer:

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Seal:

LICENSED ARCHITECT YI-SU JEFF CHEN #17977 9/30/07 RENEWAL 2007 STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MING HSIU CHEN M# M13602 EXP. 8/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

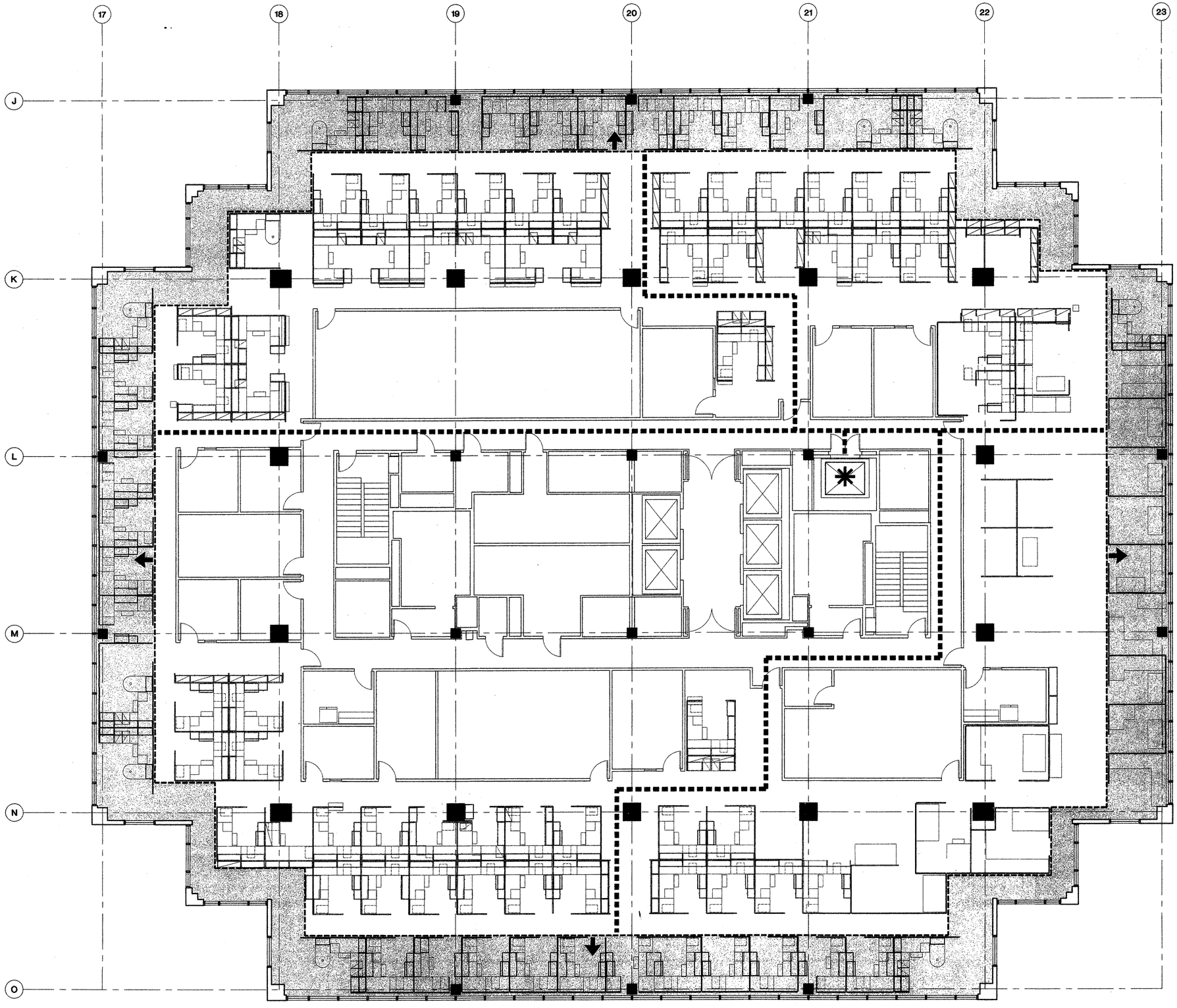
Sheet Title:

NINETEENTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A219

Apr 19, 2006 - 11:54am 05155 - A219



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR WORK COMPLETE
SW - 10/2/06 - ALL OK

NE - 11/7/06 - ALL OK
David Mitten
DMays

N

OFFICE OF STATE FIRE MARSHAL
APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by: 5/5/07

450 N STREET

BOARD OF EQUALIZATION
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FAX (415) 512-7120

Seal:

LICENSED ARCHITECT
JEFFREY CHEN
#17977
4/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED CIVIL ENGINEER
M19500
EXPIRATION 07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

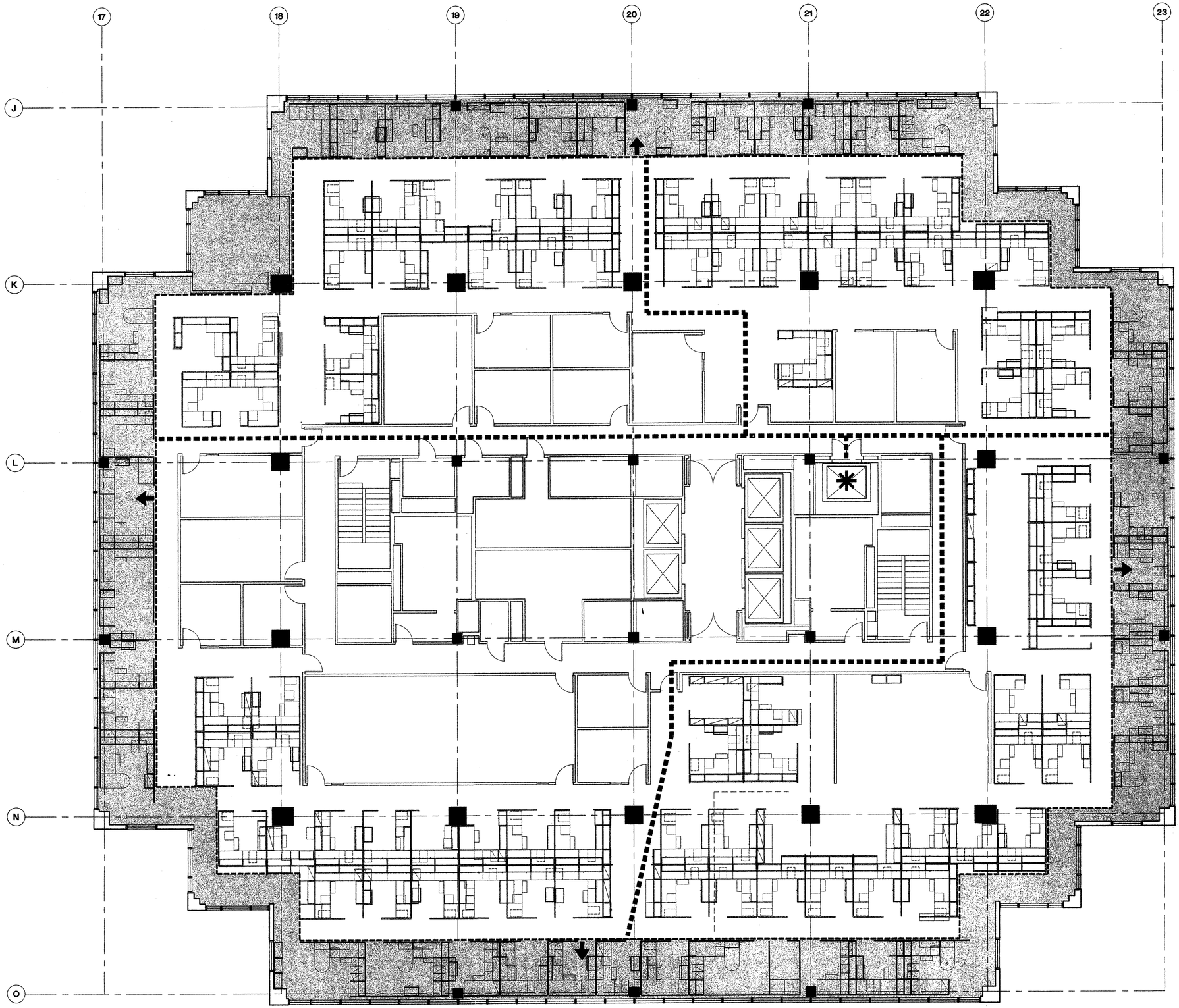
Sheet Title:

TWENTIETH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A220

Apr 19, 2006 - 11:54am 05155 - A220



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A2.02 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A2.02 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A2.02 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR WORK COMPLETE
SW - 9/26/06 - ALL OK

P.E. - 11/3/06 - ALL OK
Dmitri Koltsov
Dmitri

N

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APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by: [signature] 11/15/06

450 N STREET

BOARD OF EQUALIZATION
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Mechanical & Life Safety Engineer:

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Seal:

LICENSED ARCHITECT
YU-SO JEFF CHEN
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-HSIU CHEN
M 19582
EXP. 8-30-07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

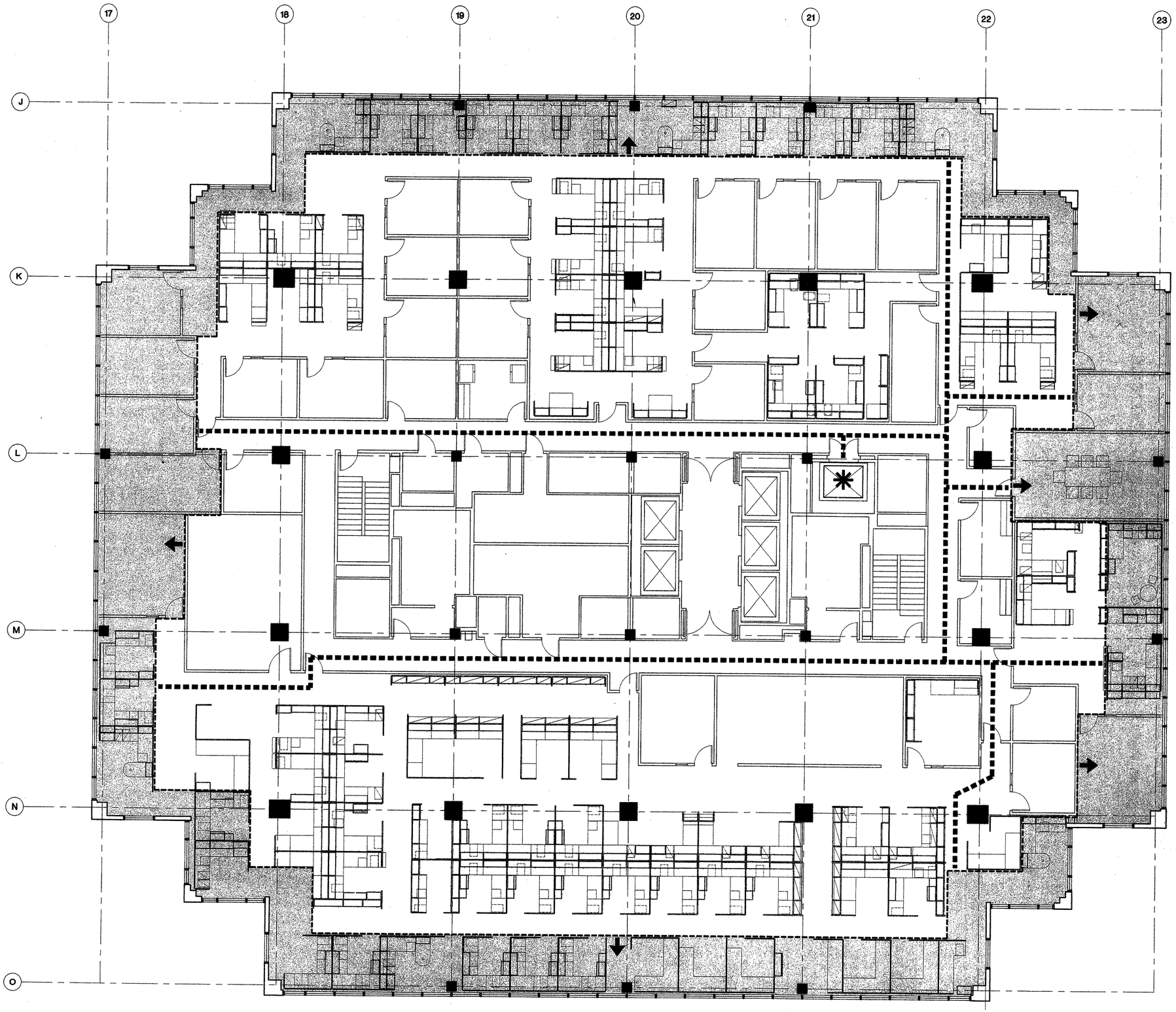
Sheet Title:

TWENTY FIRST FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A221

Apr 19, 2006 - 11:54am 05155 - A221



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A2@2 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A2@2 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A2@2 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.

INTERIOR WORK COMPLETE
SW - 9/22/06 OK - ALL OK

NE - 10/30/06 - ALL OK
David Hulteen
DMayo

~~NO LATER THAN~~
ADD
NO OUTSTANDING WATER DAMAGE ISSUES - 5/8/07
David Hulteen
DMayo

N

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APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by: 5/03/07

450 N STREET

BOARD OF EQUALIZATION
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Mechanical & Life Safety Engineer:

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Seal:

LICENSED ARCHITECT
YU-SO JEFF HSIEH
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-HSIN CHEN
M19582
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

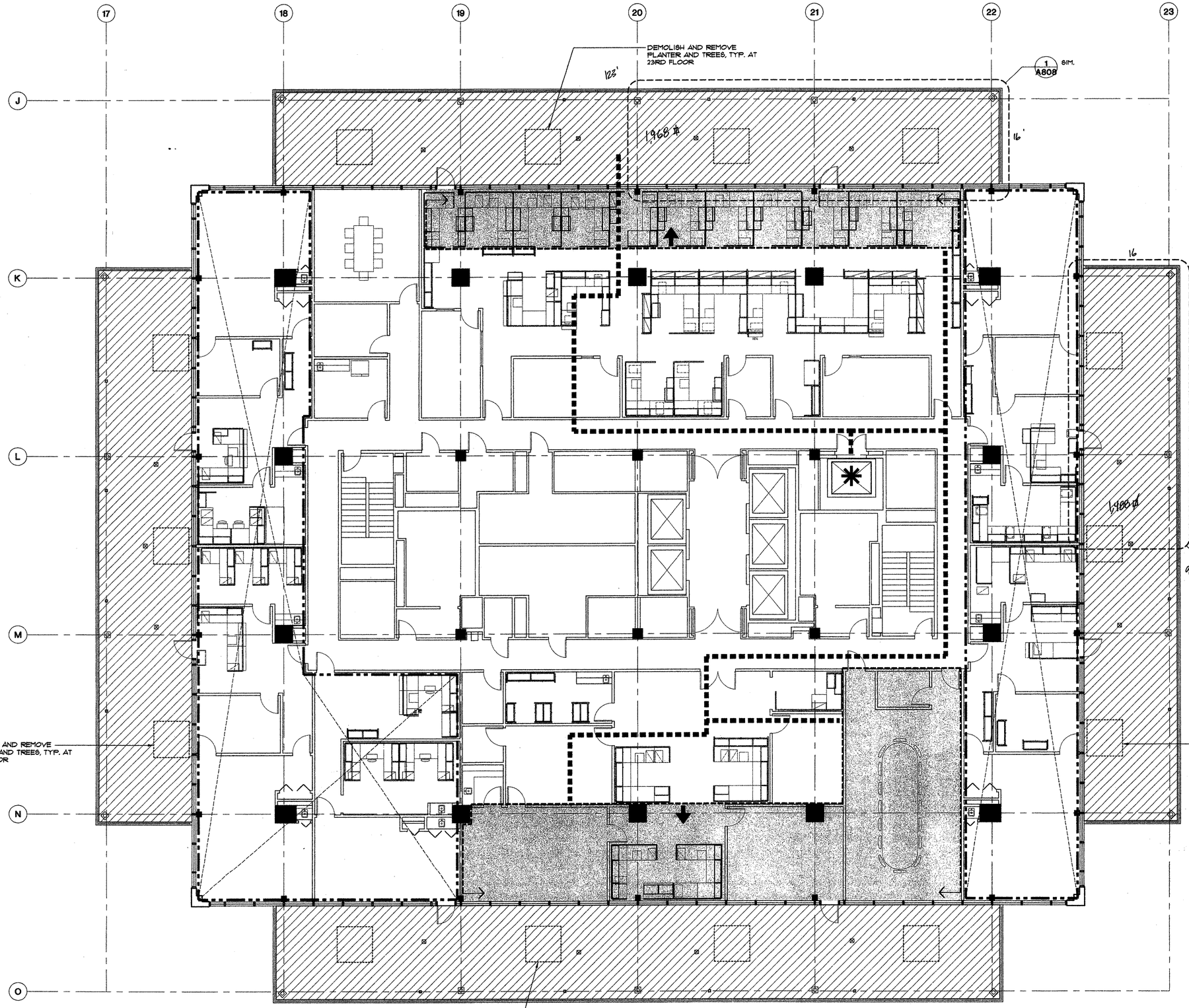
Sheet Title:

TWENTY SECOND FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A222

Apr 19, 2006 - 11:54am 05155 - A222



LEGEND

- EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.
- FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE
- REMOVE AND REPLACE EXISTING DECK SYSTEM

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.
3. SECURED AREA - BOARD MEMBER OFFICES

INTERIOR WORK COMPLETE
EC - ALL OK - 12/28/06

FE - ALL OK - 1/2/07
David Chatterton
DMay

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Reviewed by: 1/30/07

450 N STREET

BOARD OF EQUALIZATION
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Mechanical & Life Safety Engineer:

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PH. (415) 512-7141
FAX (415) 512-7120

Seal:

LICENSED ARCHITECT — MING-HSIU CHEN — #17977 — 9/30/07 RENEWAL DATE — STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER — MING-HSIU CHEN — M13582 — EXP. 9/30/07 — MECHANICAL — STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

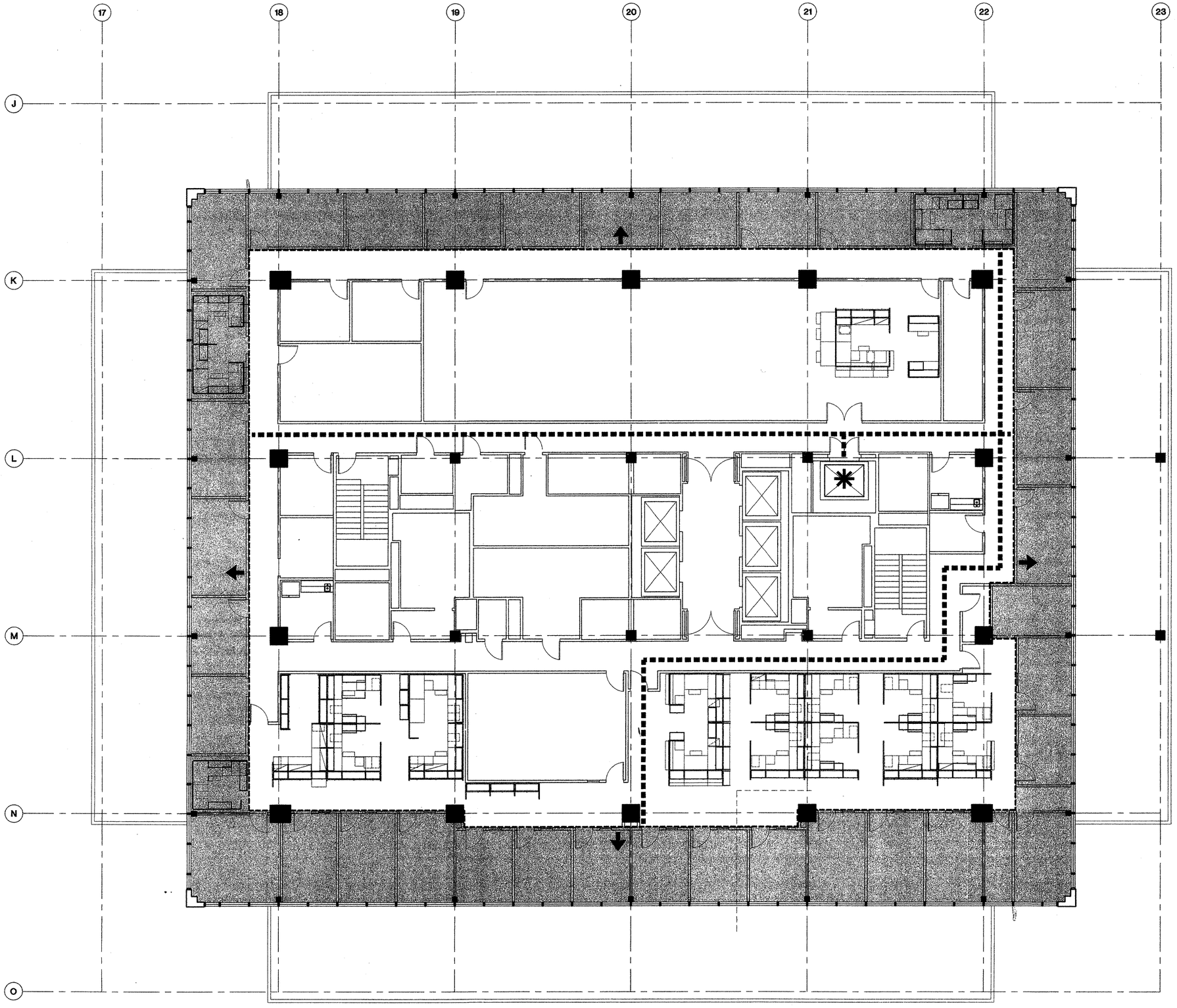
Sheet Title:

TWENTY THIRD FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A223

Apr 19, 2006 - 11:55am 05155 - A223



LEGEND

EXTENT OF ALLOWABLE ACCESS TO TENANT SPACE AT PERIMETER TO PERFORM WORK. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

RESTRICTED ACCESS - COORDINATE ACCESS WITH TENANT. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

ALLOWABLE PATH TO PERIMETER TENANT SPACE FROM FREIGHT ELEVATOR. REFER TO SHEET A202 FOR ADDITIONAL INFORMATION.

FREIGHT ELEVATOR - CONSTRUCTION PERSONNEL ACCESS TO TENANT SPACE

GENERAL NOTES

1. PROTECT FLOORING AND INTERIOR FINISHES ON CONSTRUCTION ACCESS PATH.
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR. CONTRACTOR SHALL VERIFY THE (E) LAYOUT.
3. PERIMETER PRIVATE OFFICES

INTERIOR WORK COMPLETE
SW - 1/8/07 - ALL OK
ME - 1/10/07 - ALL OK
David Rutherford
DMayS

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APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.
Reviewed by: 5/03/06

N

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

CLIENT:

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West Sacramento, CA 95605
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FAX (415) 512-7120

Seal:

LICENSED ARCHITECT
#17977
1/31/2007
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MECHANICAL
M19582
EXP. 8/31/07
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

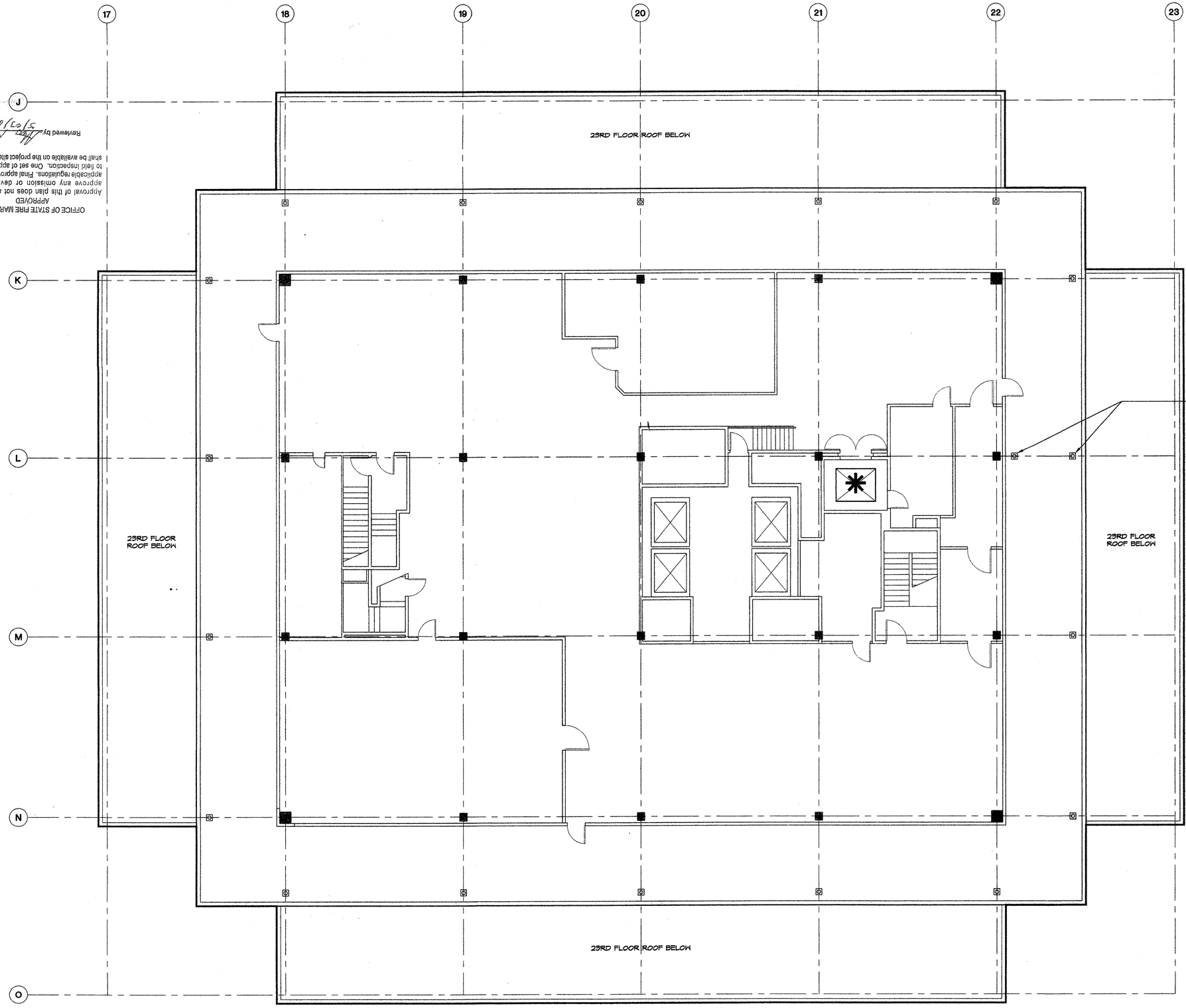
Sheet Title:

TWENTY FOURTH FLOOR PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A224

Apr 19, 2006 - 11:55am 05155 - A224



GENERAL NOTES

1. PENTHOUSE - PERMIETER ACCESSIBLE TO CONSTRUCTION PERSONNEL
2. INTERIOR LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR

Reviewed by [illegible] 4/25/06

OFFICE OF STATE FIRE MARSHAL
APPROVED
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450 N STREET

BOARD OF EQUALIZATION
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Seal:

LICENSED ARCHITECT YUTSO JEFF CHEN #17977 4/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MECHANICAL YUTSO JEFF CHEN M 19599 EXP. 9/30/07 STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

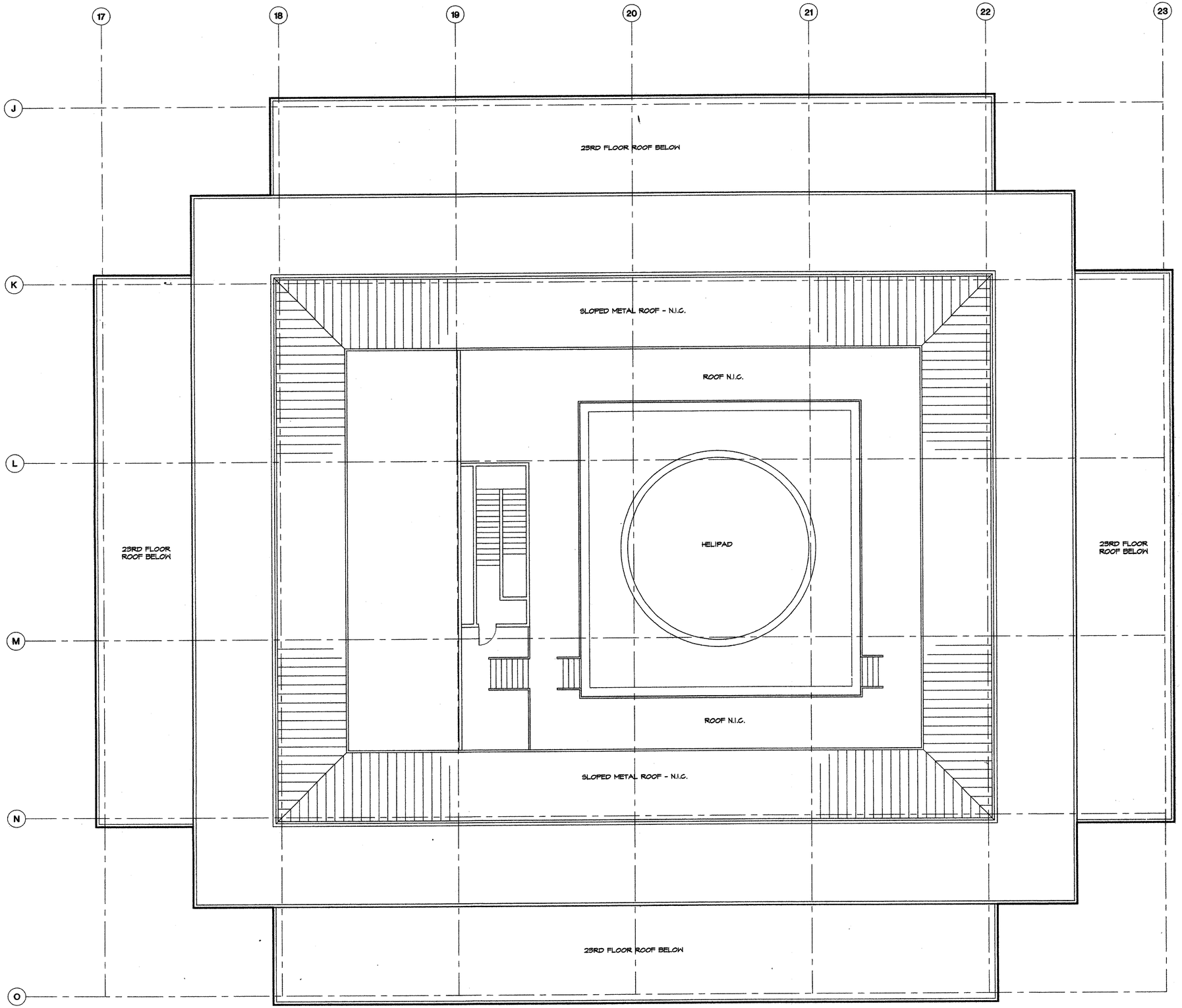
Sheet Title:

PENTHOUSE PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A225

Apr 19, 2006 - 11:55am 05155 - A225



GENERAL NOTES

1. ROOF - N.I.C.
2. LAYOUT PROVIDED AS INFORMATION TO CONTRACTOR.
3. HELIPAD AVAILABLE TO CONTRACTOR FOR PRODUCT DELIVERY WITH PRIOR OWNER APPROVAL.

N

OFFICE OF STATE FIRE MARSHAL
APPROVED

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Reviewed by: 5/03/07

450 N STREET

BOARD OF EQUALIZATION
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Mechanical & Life Safety Engineer:

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Seal:

LICENSED ARCHITECT
#17977
4/30/07
RENEWAL DATE
YI-TSO JEFF CHEN
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-HSIU CHEN
M19582
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

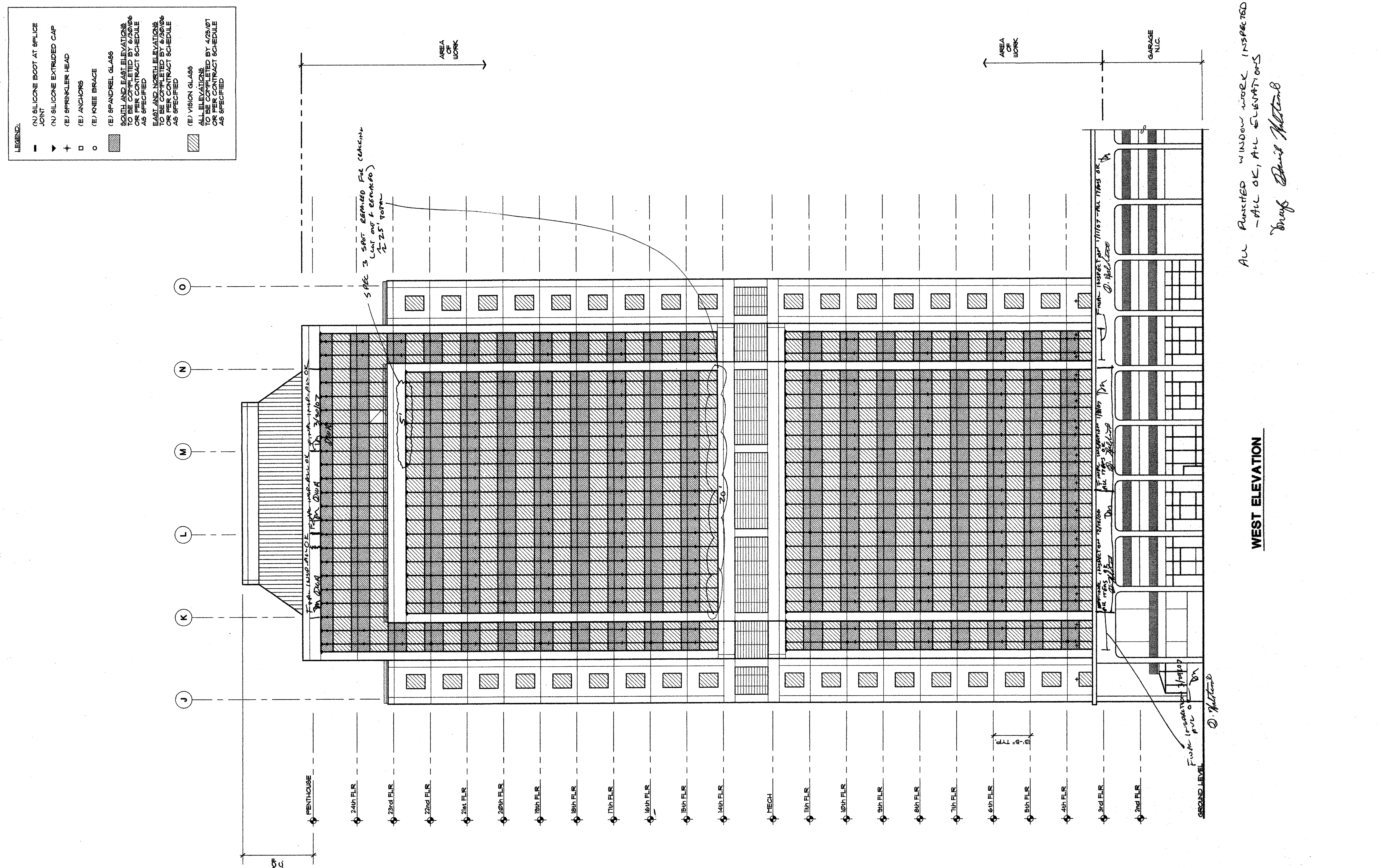
Sheet Title:

ROOF PLAN

Scale:	1/8" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A226

Apr 19, 2006 - 11:56am 05155 - A226



450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

CLIENT:

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Department of General Services
Real Estate Services Division
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FAX (415) 512-7120

Seal:

LICENSED ARCHITECT
YI-TSO JEFF CHEN
#17971
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-HSIU CHEN
M19582
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

Sheet Title:

WEST ELEVATION

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Reviewed by: 5/3/06

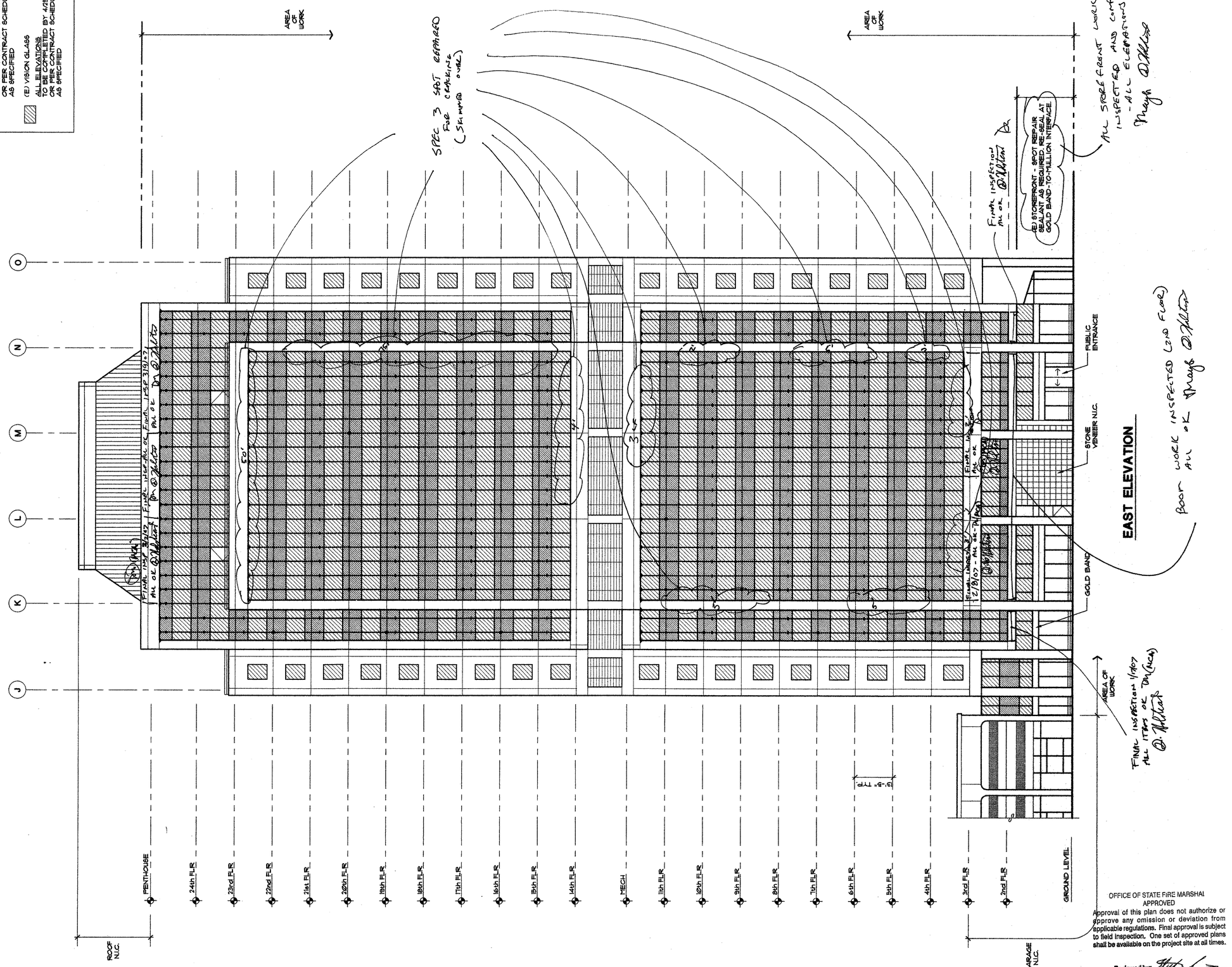
Scale:	1/16" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A301

Apr 19, 2006 - 11:56am 05155 - A301-304

LEGEND:

- (N) SILICONE BOOT AT SPLICE JOINT
- (N) SILICONE EXTRUDED CAP
- (E) SPRINKLER HEAD
- (E) ANCHORS
- (E) KNEE BRACE
- (E) SPANDREL GLASS — SOUTH AND EAST ELEVATIONS TO BE COMPLETED BY 6/30/06 OR PER CONTRACT SCHEDULE AS SPECIFIED; EAST AND NORTH ELEVATIONS TO BE COMPLETED BY 6/30/06 OR PER CONTRACT SCHEDULE AS SPECIFIED
- (E) VISION GLASS — ALL ELEVATIONS TO BE COMPLETED BY 4/25/07 OR PER CONTRACT SCHEDULE AS SPECIFIED



EAST ELEVATION

OFFICE OF STATE FIRE MARSHAL
APPROVED
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Reviewed by: 5/23/07

450 N STREET

BOARD OF EQUALIZATION
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Seal:

LICENSED ARCHITECT YI-HSIU JEFF CHEN #17977 9/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MENG-HSIU CHEN M19582 EXP. 9/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

Sheet Title:

EAST ELEVATION

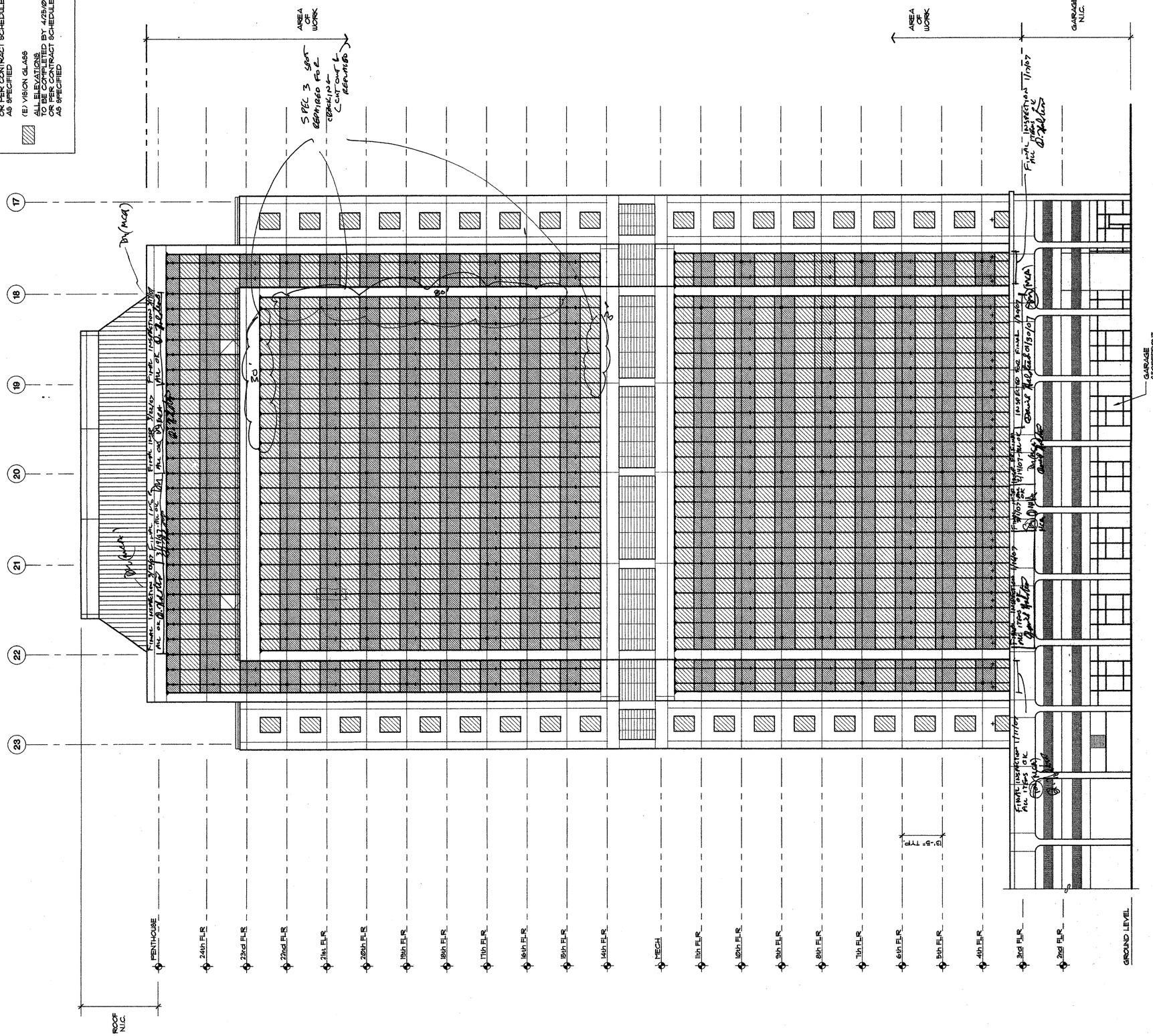
Scale:	1/16" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A302

Apr 19, 2006 - 11:58am 05155 - A301-304

LEGEND:

- (N) SILICONE BOOT AT SPLICE JOINT
- (N) SILICONE EXTRUDED CAP
- (E) SPRINKLER HEAD
- (E) ANCHORS
- (E) KNEE BRACE
- (E) SPANDREL GLASS — SOUTH AND EAST ELEVATIONS TO BE COMPLETED BY 6/30/06 OR PER CONTRACT SCHEDULE AS SPECIFIED; EAST AND NORTH ELEVATIONS TO BE COMPLETED BY 6/30/06 OR PER CONTRACT SCHEDULE AS SPECIFIED
- (E) VISION GLASS — ALL ELEVATIONS TO BE COMPLETED BY 4/25/07 OR PER CONTRACT SCHEDULE AS SPECIFIED



SOUTH ELEVATION

OFFICE OF STATE FIRE MARSHAL
APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by: _____ 3/5/07

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

CLIENT:

State of California
Department of General Services
Real Estate Services Division
707 Third Street Suite 3-305
West Sacramento, CA 95605
Phone: (916) 376-1700

Architect:

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ARCHITECTS | ENGINEERS
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Phone: (415) 986-3873
Fax: (415) 296-0586

Environmental Forensics:

LaCroix Davis LLC

Mechanical & Life Safety Engineer:

MHC ENGINEERS
150 8TH STREET
SAN FRANCISCO, CA 94103
PH (415) 512-7141
FAX (415) 512-7120

Seal:

LICENSED ARCHITECT #17977 YI-TSO JEFF CHEN RENEWAL 08/31/07 STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MENG-HSIU CHEN M19582 EXP. 9/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

Sheet Title:

SOUTH ELEVATION

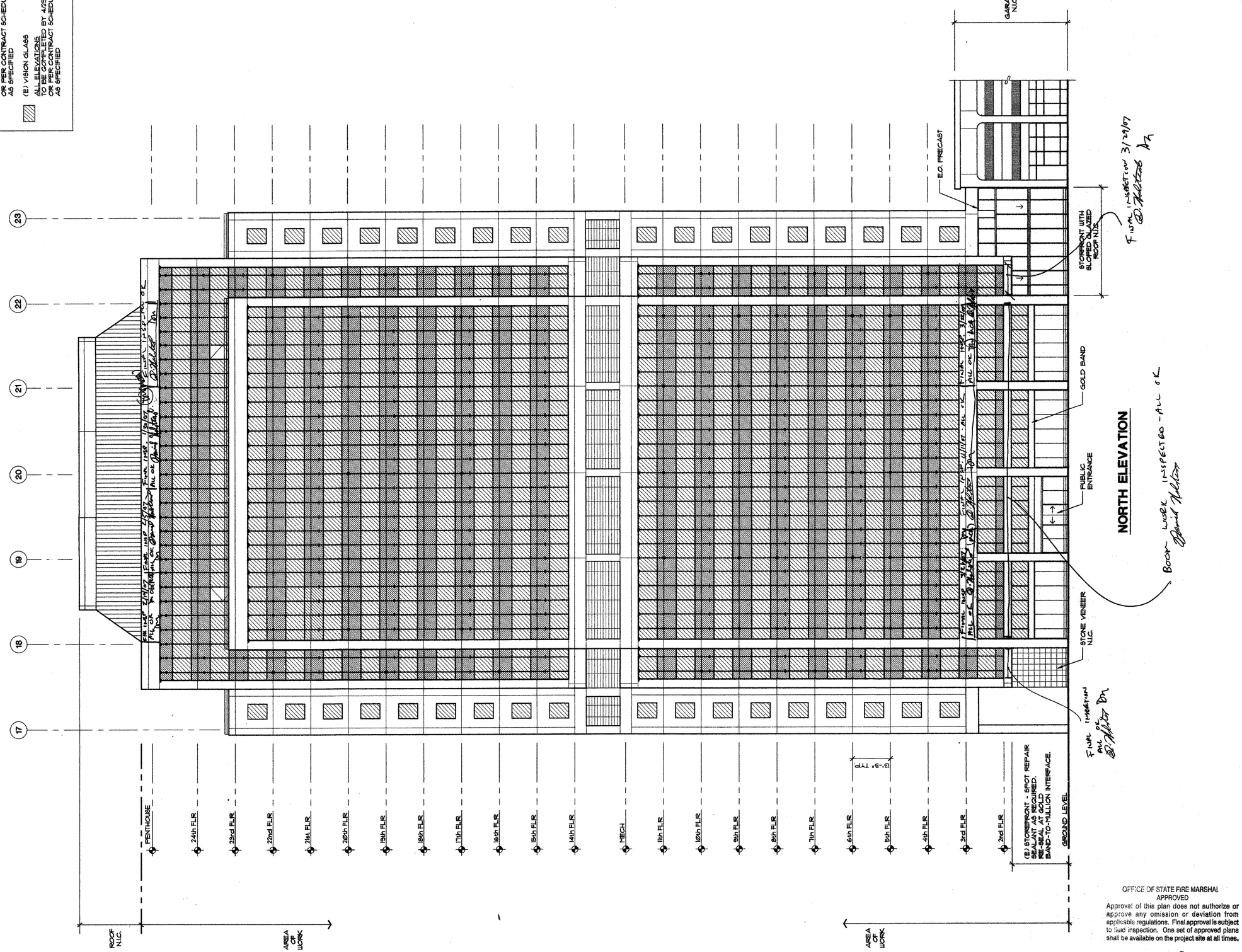
Scale:	1/16" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A303

Apr 19, 2006 - 11:58am 05155 - A301-304

LEGEND:

- (N) SILICONE BOOT AT SPLICE JOINT
- (N) SILICONE EXTRUDED CAP
- (E) SPRINKLER HEAD
- (E) ANCHORS
- (E) KNEE BRACE
- (E) SPANDREL GLASS — SOUTH AND EAST ELEVATIONS TO BE COMPLETED BY 6/30/06 OR PER CONTRACT SCHEDULE AS SPECIFIED; EAST AND NORTH ELEVATIONS TO BE COMPLETED BY 6/30/06 OR PER CONTRACT SCHEDULE AS SPECIFIED
- (E) VISION GLASS — ALL ELEVATIONS TO BE COMPLETED BY 4/25/07 OR PER CONTRACT SCHEDULE AS SPECIFIED



NORTH ELEVATION

OFFICE OF STATE FIRE MARSHAL
APPROVED

Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.

Reviewed by: 3/29/07

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

CLIENT:

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Real Estate Services Division
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Seal:

LICENSED ARCHITECT — #17977 — 9/30/07 RENEWAL DATE — WEI-SO JEFF CHEN — STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER — MENG-HSIU CHEN — M19582 — EXP. 9/30/07 — MECHANICAL — STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	CONSTRUCTION SET	04.19.06

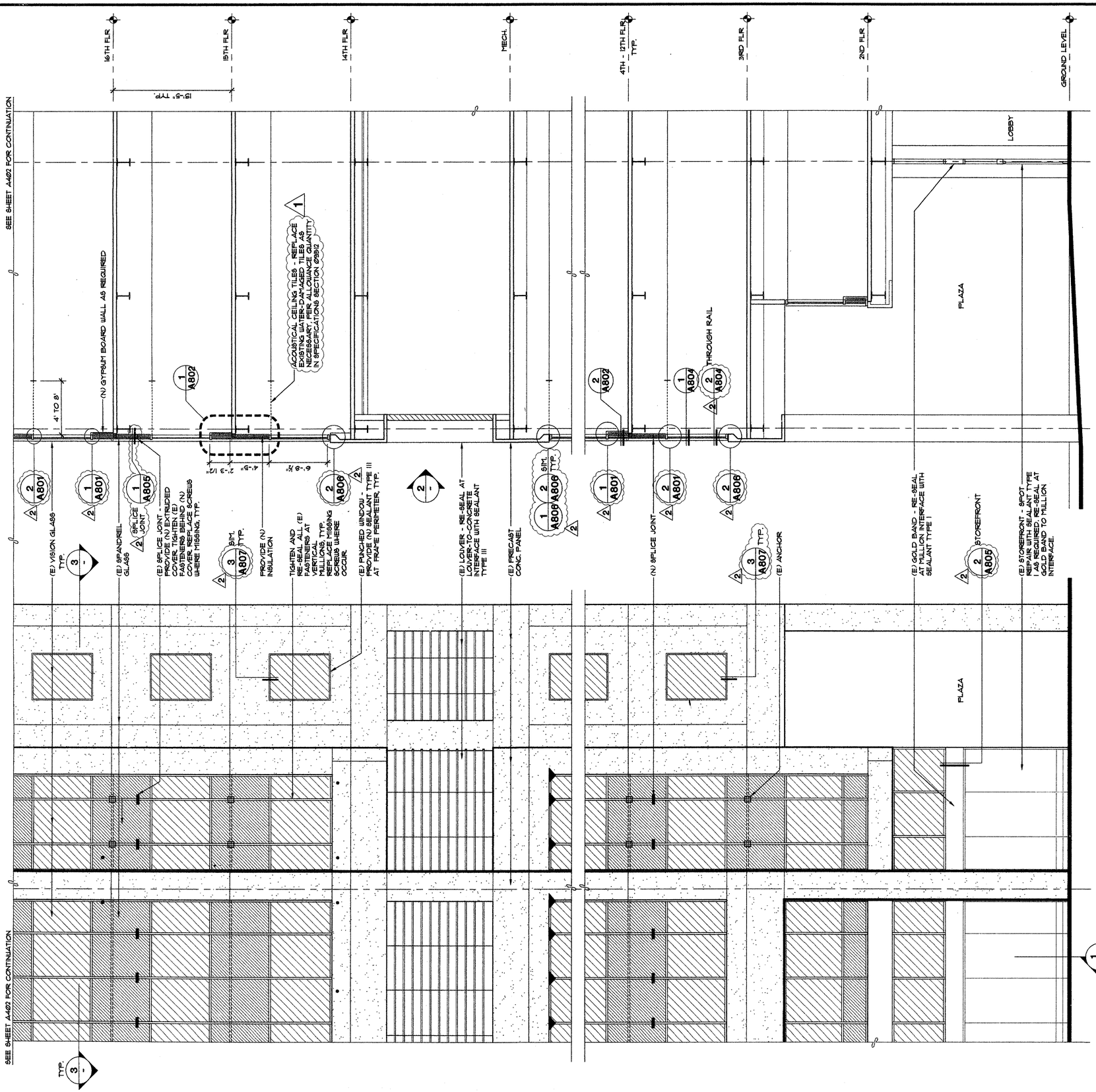
Sheet Title:

NORTH ELEVATION

Scale:	1/16" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A304

Apr 19, 2006 - 11:56am 05155-A301-304



1 PARTIAL WALL SECTION
3/16"=1'-0"

SEALANT SCHEDULE

TYPE I SPECIFIED BY TREMCO
LOCATION: ALUMINUM FRAME JOINTS

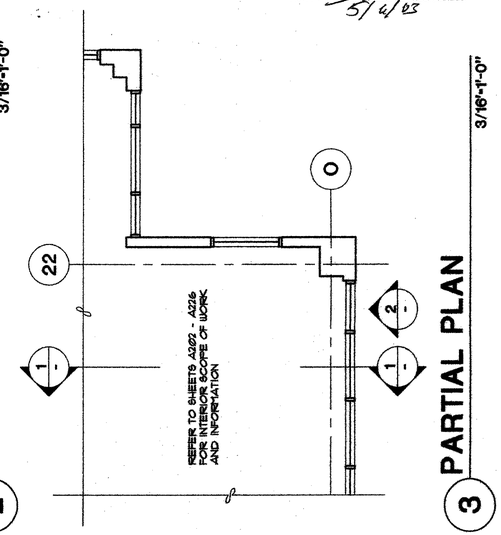
TYPE II SPECIFIED BY TREMCO
LOCATION: GLAZING JOINTS

TYPE III SPECIFIED BY TREMCO
LOCATION: JOINTS BETWEEN PRECAST CONCRETE PANELS AND ALUMINUM FRAMES

TYPE IV TREMSIL 600 WHITE BY TREMCO
LOCATION: JOINTS AT TILE DECK

2 PARTIAL NORTH ELEVATION
3/16"=1'-0"

3 PARTIAL PLAN
3/16"=1'-0"



OFFICE OF STATE FIRE MARSHAL
APPROVED
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Reviewed by: 5/4/07

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

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MHC ENGINEERS
160 8TH STREET
SAN FRANCISCO, CA 94103
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FAX (415) 512-7150

Seal:

LICENSED ARCHITECT YI-TSO JEFF CHEN #17977 9/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MEIRS HSIU CHEN M19582 EXP. 9/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

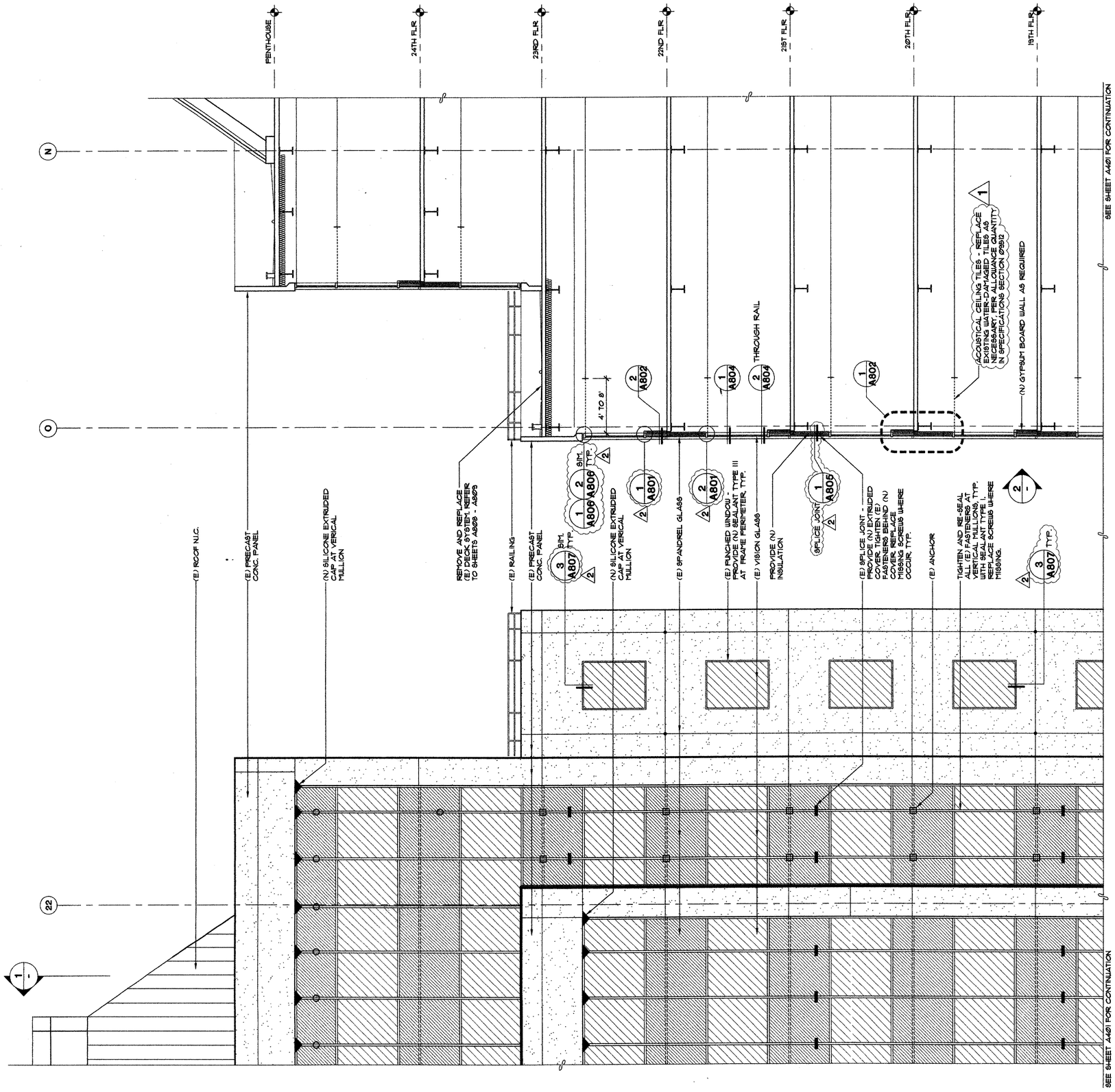
NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #1	04.03.06
	ADDENDUM #2	04.10.06
	CONSTRUCTION SET	04.19.06

Sheet Title:
SECTION PARTIAL PLAN & ELEVATION

Scale:	3/16" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A401

Apr 19, 2006 - 3:59pm 05155 - A401



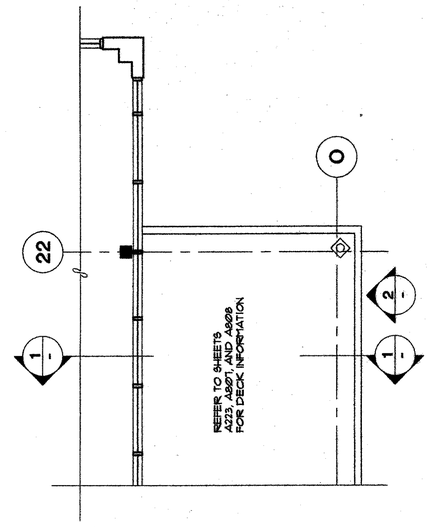
1 PARTIAL WALL SECTION
3/16"=1'-0"

SEALANT SCHEDULE

TYPE I	SPECTREM 1 BY TREMCO	LOCATION: ALUMINUM FRAME JOINTS
TYPE II	SPECTREM 2ETT BY TREMCO	LOCATION: GLAZING JOINTS
TYPE III	SPECTREM 3 BY TREMCO	LOCATION: FOR JOINTS BETWEEN PRECAST CONCRETE PANELS AND ALUMINUM FRAMES
TYPE IV	TREMSIL 600 WHITE BY TREMCO	LOCATION: JOINTS AT TILE DECK

2 PARTIAL NORTH ELEVATION
3/16"=1'-0"

3 PARTIAL 23RD FLOOR PLAN
3/16"=1'-0"



OFFICE OF STATE FIRE MARSHAL
APPROVED
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Reviewed by: 4/4/06

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

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FAX (415) 512-7105

Seal:

LICENSED ARCHITECT — TIMOTHY JEFFRIES — #17871 — 9/30/07 — STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER — MENG-HSIU CHEN — M19582 — EXP. 9/30/07 — MECHANICAL — STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #1	04.03.06
	ADDENDUM #2	04.10.06
	CONSTRUCTION SET	04.19.06

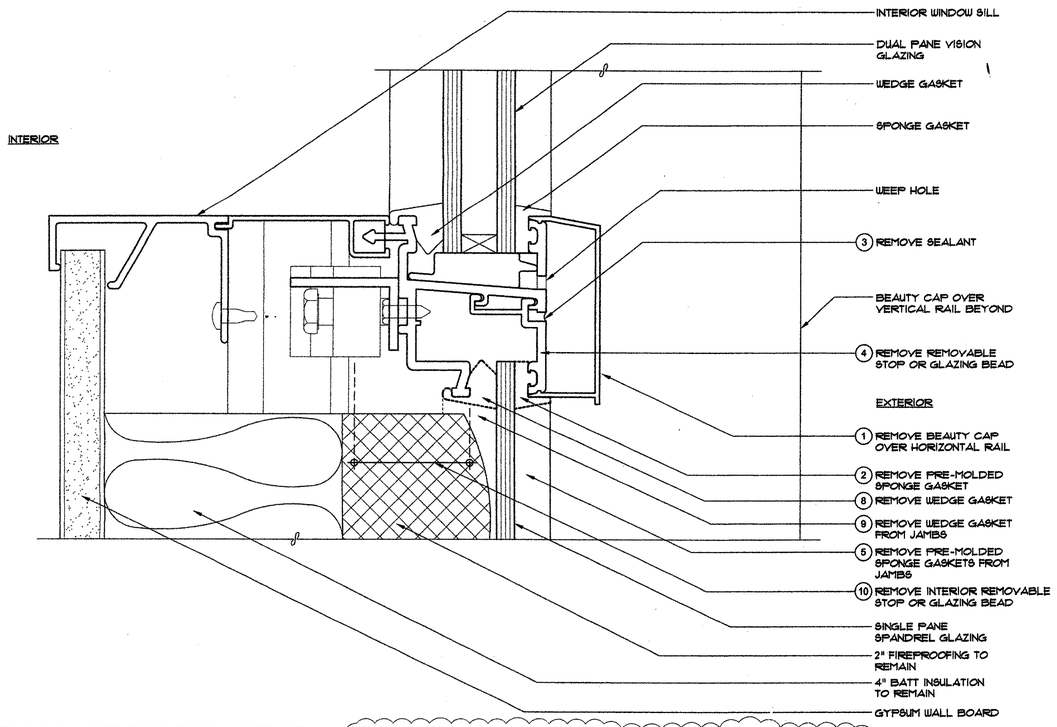
Sheet Title:

SECTION PARTIAL PLAN & ELEVATION

Scale:	3/16" = 1'-0"
Project #	05155.00
Date:	-
Drawn:	RR
Checked:	JC

A402

Apr 19, 2006 - 4:01pm 05155 - A402



1E TYPICAL SPANDREL HEAD - EXISTING AND SELECTIVE DEMOLITION

FULL SIZE

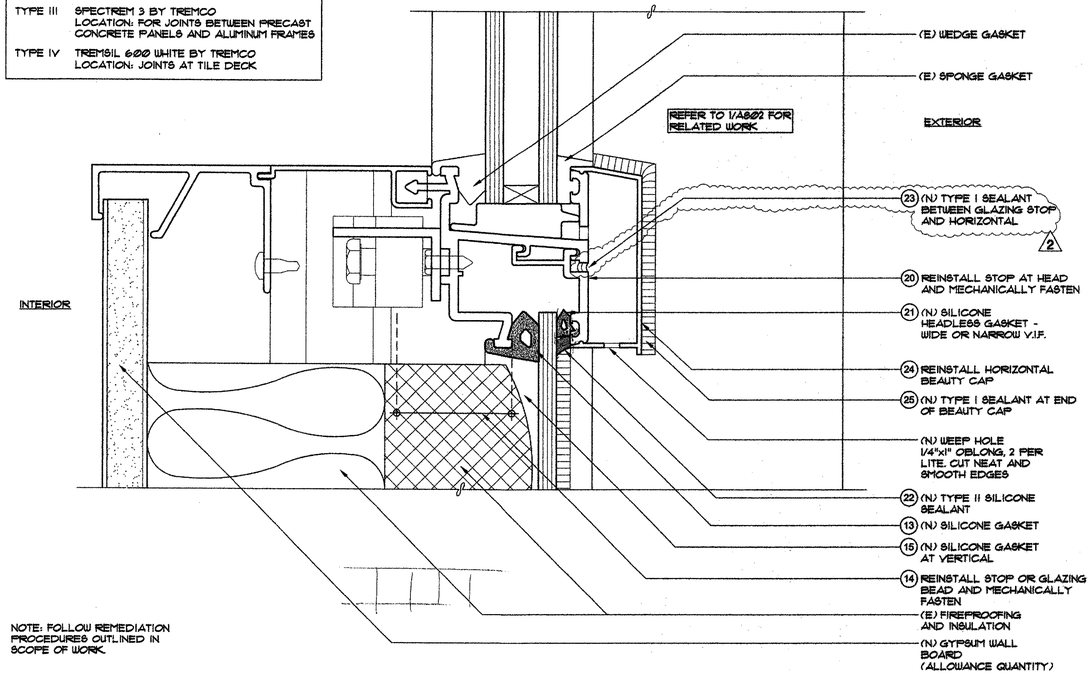
SEALANT SCHEDULE

TYPE I	SPECTREM 1 BY TREMCO	LOCATION: ALUMINUM FRAME JOINTS
TYPE II	SPECTREM 2ETT BY TREMCO	LOCATION: GLAZING JOINTS
TYPE III	SPECTREM 3 BY TREMCO	LOCATION: FOR JOINTS BETWEEN PRECAST CONCRETE PANELS AND ALUMINUM FRAMES
TYPE IV	TREMSIL 600 WHITE BY TREMCO	LOCATION: JOINTS AT TILE DECK

LEGEND

(#) RECOMMENDED SEQUENCE AT SPANDREL AS NUMBERED BY STEP. CONTRACTOR TO FINALIZE PROJECT PROCESS AND SEQUENCE.

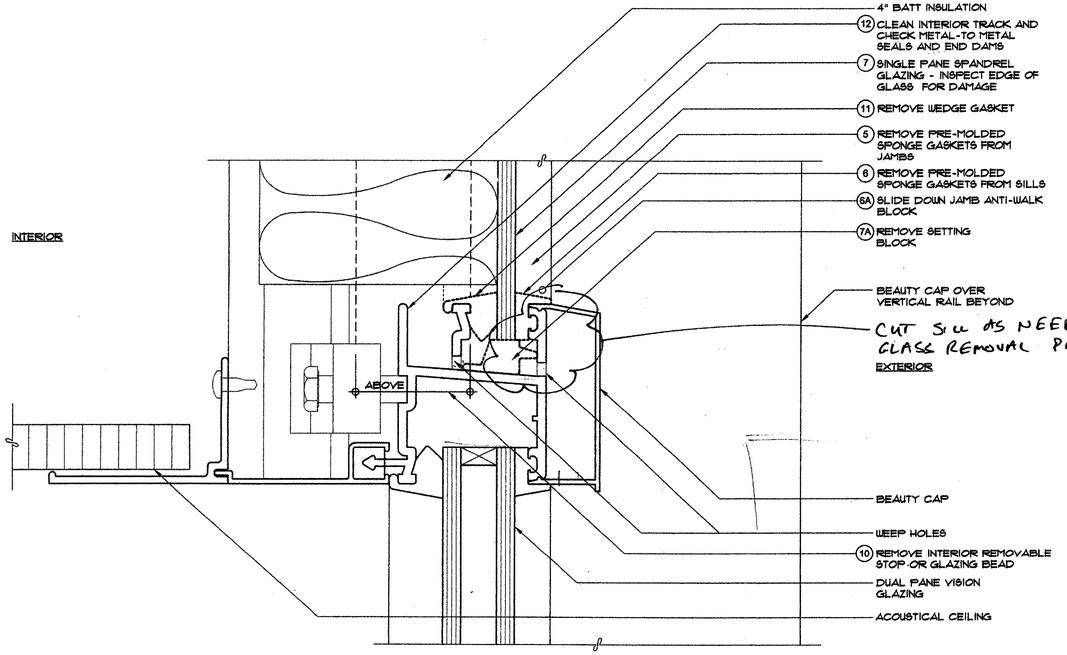
REFER TO 1/A802 FOR RELATED WORK



NOTE: FOLLOW REMEDIATION PROCEDURES OUTLINED IN SCOPE OF WORK.

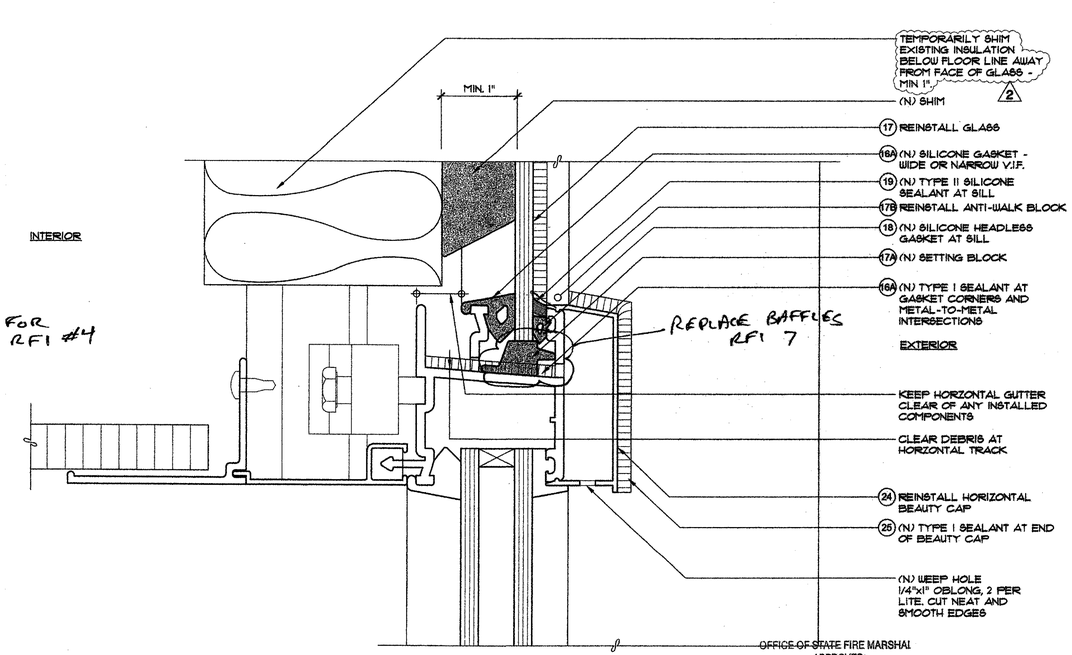
1 TYPICAL SPANDREL HEAD - REMEDIATION

FULL SIZE



2E TYPICAL SPANDREL SILL - EXISTING AND SELECTIVE DEMOLITION

FULL SIZE



NOTE: FOLLOW REMEDIATION PROCEDURES OUTLINED IN SCOPE OF WORK.

2 TYPICAL SPANDREL SILL - REMEDIATION

FULL SIZE

~~OFFICE OF STATE~~ FIRE MARSHAL
APPROVED
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Reviewed by: 5/16/08

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

CLIENT:

State of California
Department of General Services
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707 Third Street Suite 3-305
West Sacramento, CA 95605
Phone: (916) 376-1700

Architect:

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ARCHITECTS | ENGINEERS
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Environmental Forensics:

LaCroix Davis LLC

Mechanical & Life Safety Engineer:

MHC ENGINEERS
100 8TH STREET
SAN FRANCISCO, CA 94103
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FAX (415) 512-7130

Seal:

LICENSED ARCHITECT JEFF CHEN #17977 RENEWAL DATE 4/30/07 STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MING-HSIU CHEN M19582 EXP. 9/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

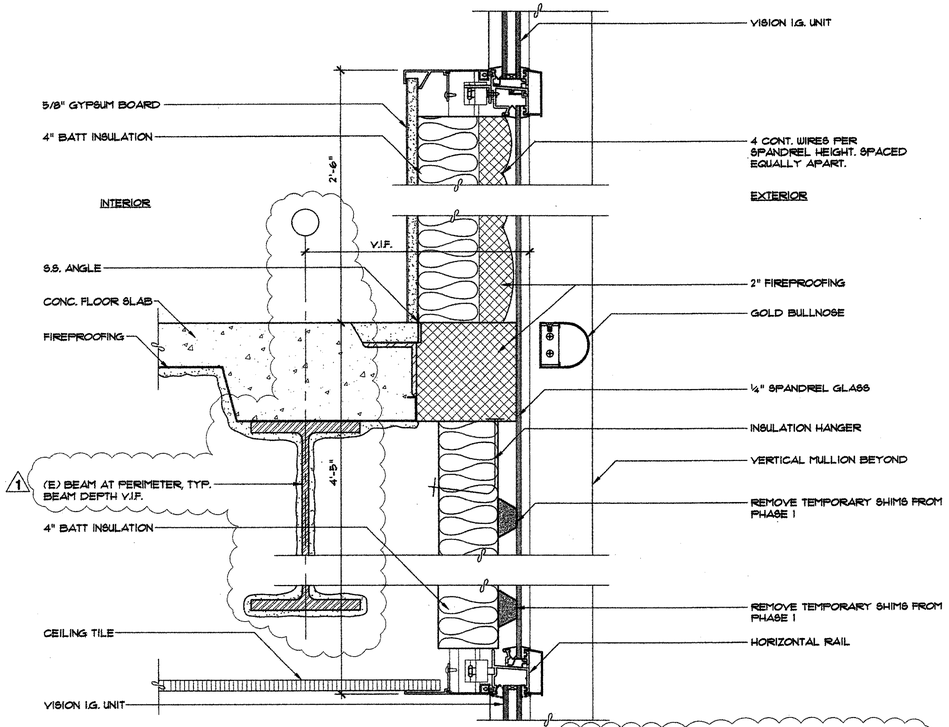
NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #1	04.03.06
	ADDENDUM #2	04.10.06
	CONSTRUCTION SET	04.19.06

Sheet Title:

DETAILS

Scale:	FULL SCALE
Project #	05155.00
Date:	-
Drawn:	RR CY
Checked:	JC

A801

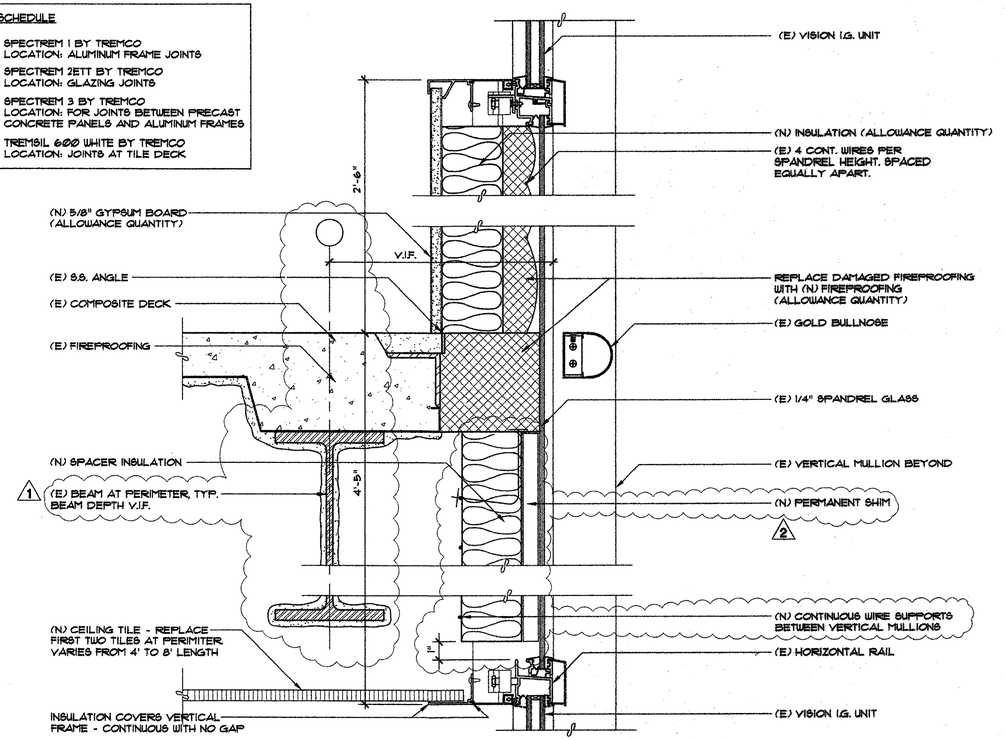


1E TYP. WALL CAVITY SECTION AT SPANDREL - EXIST. & SELECTIVE DEMO.

1 3" = 1'-0"

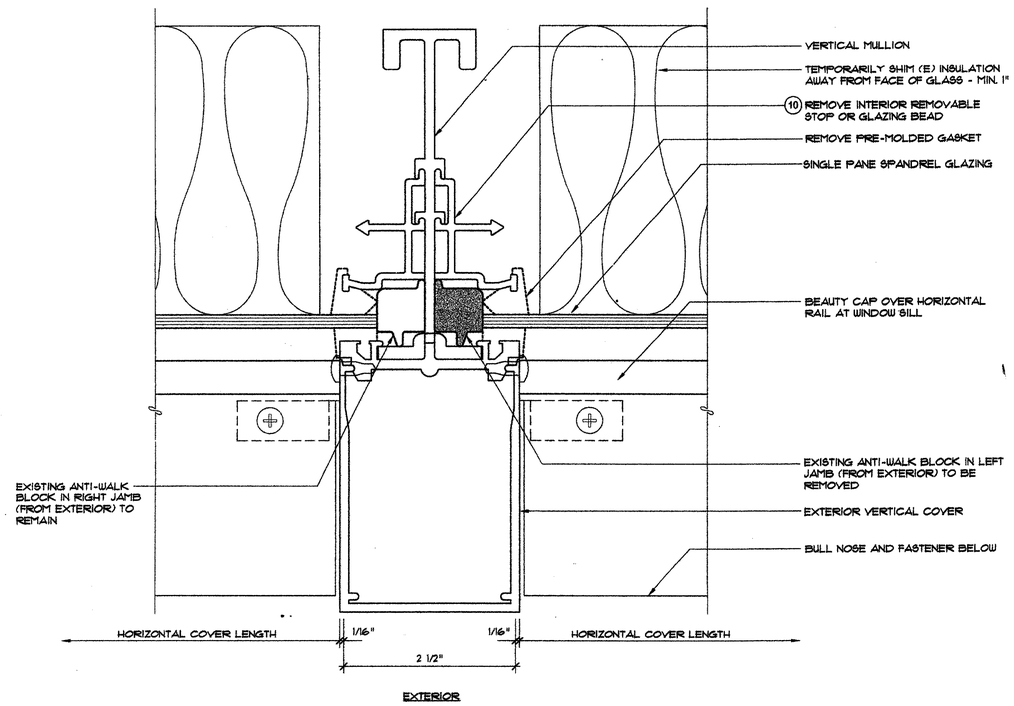
SEALANT SCHEDULE

TYPE I	SPECTREM 1 BY TREMCO LOCATION: ALUMINUM FRAME JOINTS
TYPE II	SPECTREM 2ETT BY TREMCO LOCATION: GLAZING JOINTS
TYPE III	SPECTREM 3 BY TREMCO LOCATION: FOR JOINTS BETWEEN PRECAST CONCRETE PANELS AND ALUMINUM FRAMES
TYPE IV	TREMSIL 600 WHITE BY TREMCO LOCATION: JOINTS AT TILE DECK



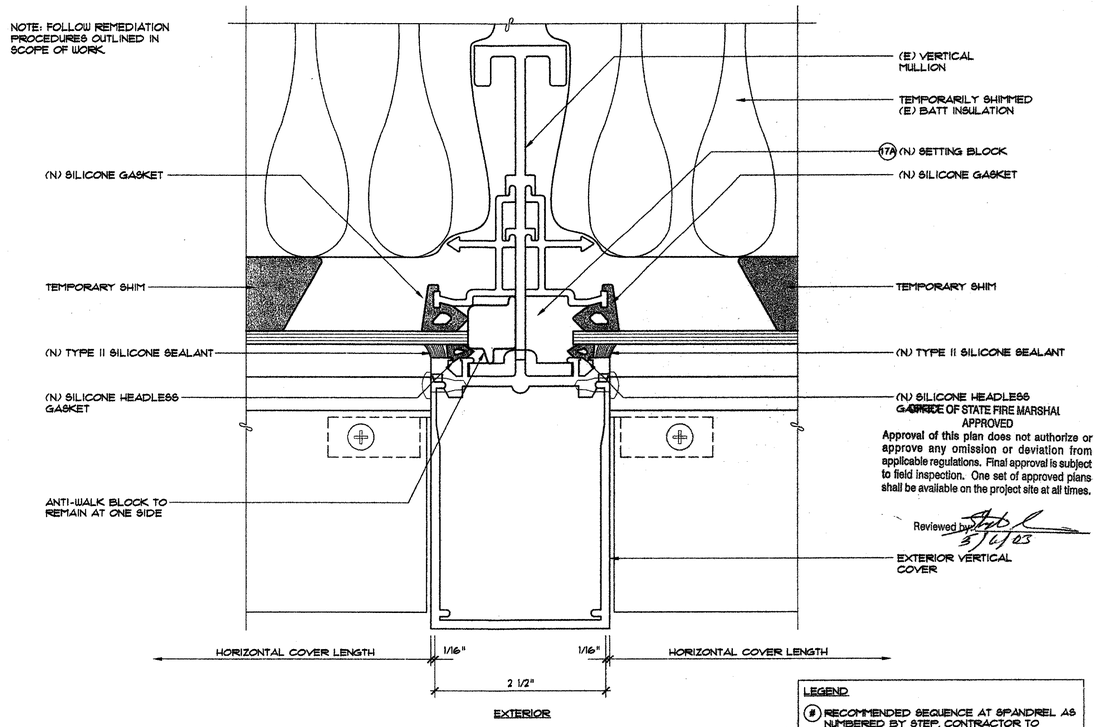
1 TYPICAL WALL CAVITY SECTION AT SPANDREL - REMEDIATION

3" = 1'-0"



2E TYPICAL MULLION AT SPANDREL - EXISTING AND SELECTIVE DEMOLITION

1 FULL SIZE



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Reviewed by: 5/6/03

LEGEND
(#) RECOMMENDED SEQUENCE AT SPANDREL AS NUMBERED BY STEP. CONTRACTOR TO FINALIZE PROJECT PROCESS AND SEQUENCE.

2 TYPICAL MULLION AT SPANDREL - REMEDIATION

FULL SIZE

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

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State of California
Department of General Services
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FAX (415) 512-7120

Seal:

LICENSED ARCHITECT JEFF CHEN #17977 9/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MENG-KSU CHEN M19582 EXP. 8/31/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

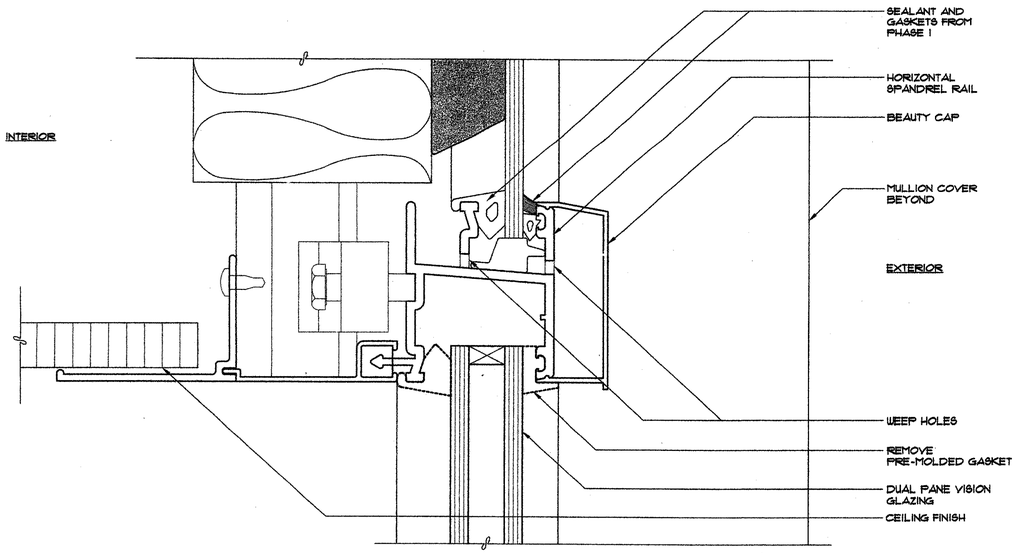
NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #1	04.03.06
	ADDENDUM #2	04.10.06
	CONSTRUCTION SET	04.19.06

Sheet Title:
DETAILS

Scale:	AS NOTED
Project #	05155.00
Date:	-
Drawn:	RR CY
Checked:	JC

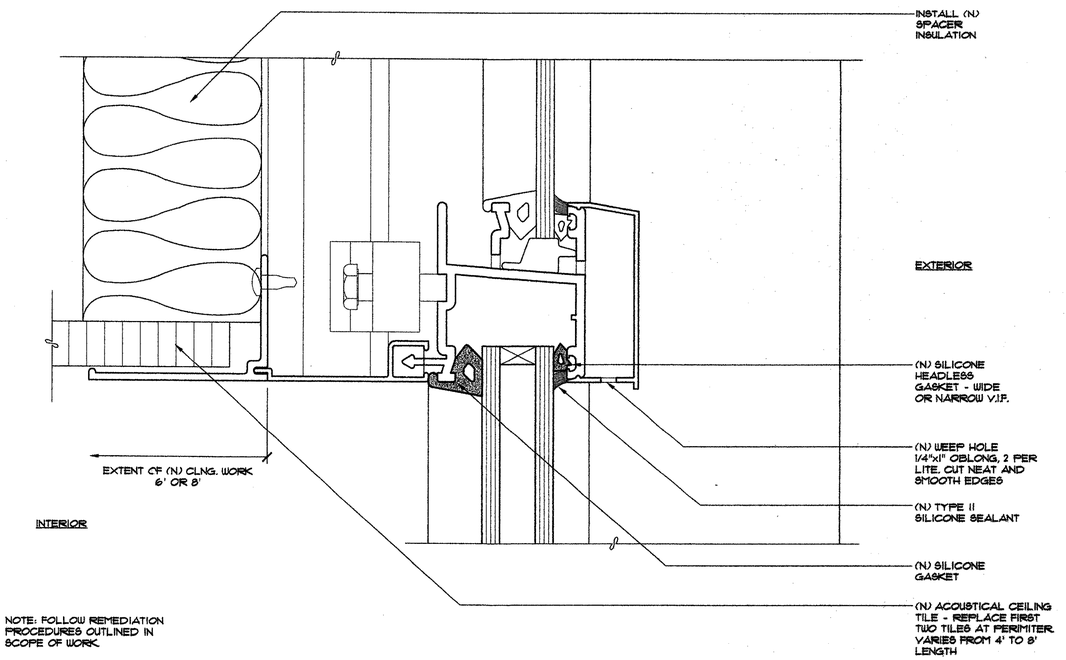
A802

Apr 19, 2006 - 1:47pm 05155-A800.dgn



1E TYPICAL VISION I.G. UNIT HEAD - EXISTING AND SELECTIVE DEMOLITION

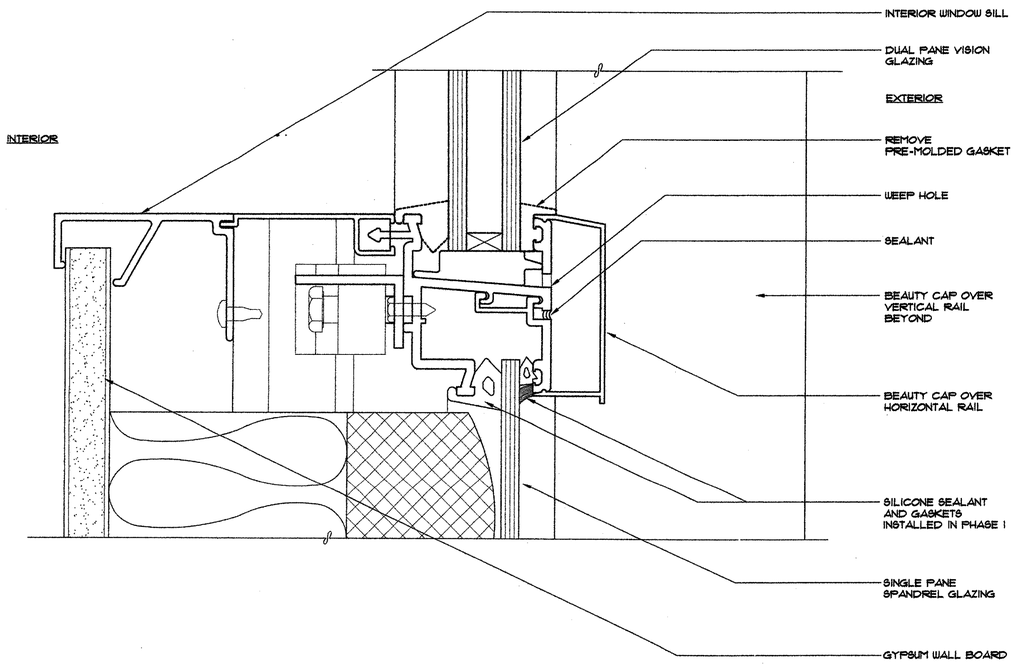
FULL SIZE



NOTE: FOLLOW REMEDIATION PROCEDURES OUTLINED IN SCOPE OF WORK.

1 TYPICAL VISION I.G. UNIT HEAD - REMEDIATION

FULL SIZE

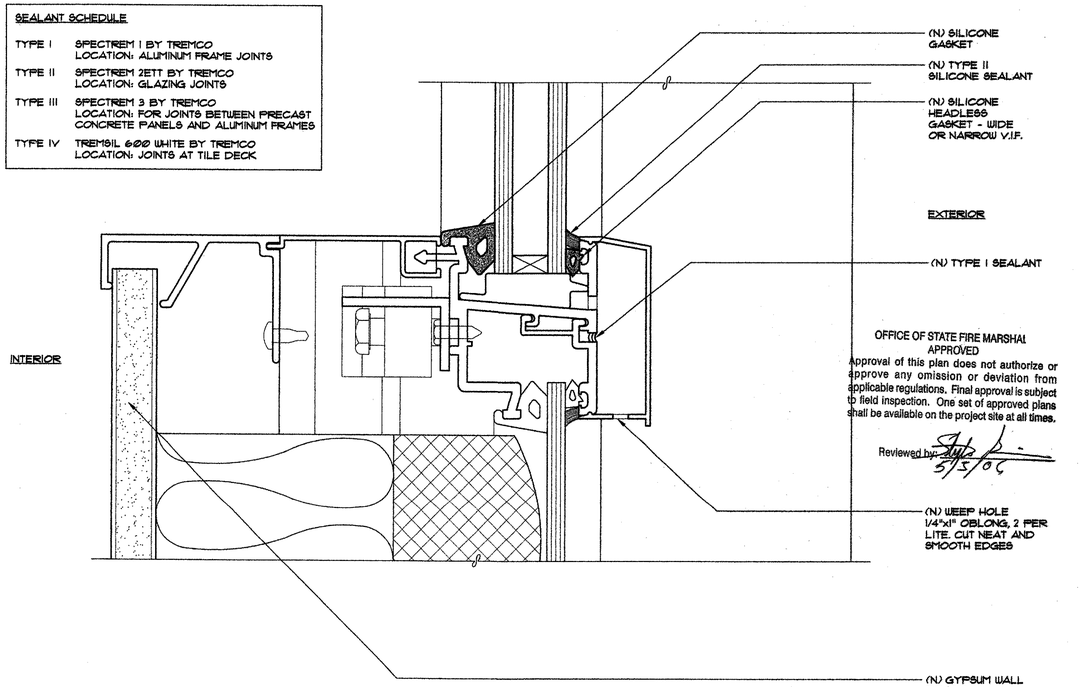


2E TYPICAL VISION I.G. UNIT HEAD - EXISTING AND SELECTIVE DEMOLITION

FULL SIZE

SEALANT SCHEDULE

TYPE I	SPECTREM 1 BY TREMCO LOCATION: ALUMINUM FRAME JOINTS
TYPE II	SPECTREM 2ETT BY TREMCO LOCATION: GLAZING JOINTS
TYPE III	SPECTREM 3 BY TREMCO LOCATION: FOR JOINTS BETWEEN PRECAST CONCRETE PANELS AND ALUMINUM FRAMES
TYPE IV	TREMSIL 600 WHITE BY TREMCO LOCATION: JOINTS AT TILE DECK



NOTE: FOLLOW REMEDIATION PROCEDURES OUTLINED IN SCOPE OF WORK.

2 TYPICAL VISION I.G. UNIT SILL - REMEDIATION

FULL SIZE

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

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FAX (415) 512-7150

Seal:

LICENSED ARCHITECT
YI-TSO JEFF CHEN
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
MENG-HSIU CHEN
M19582
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

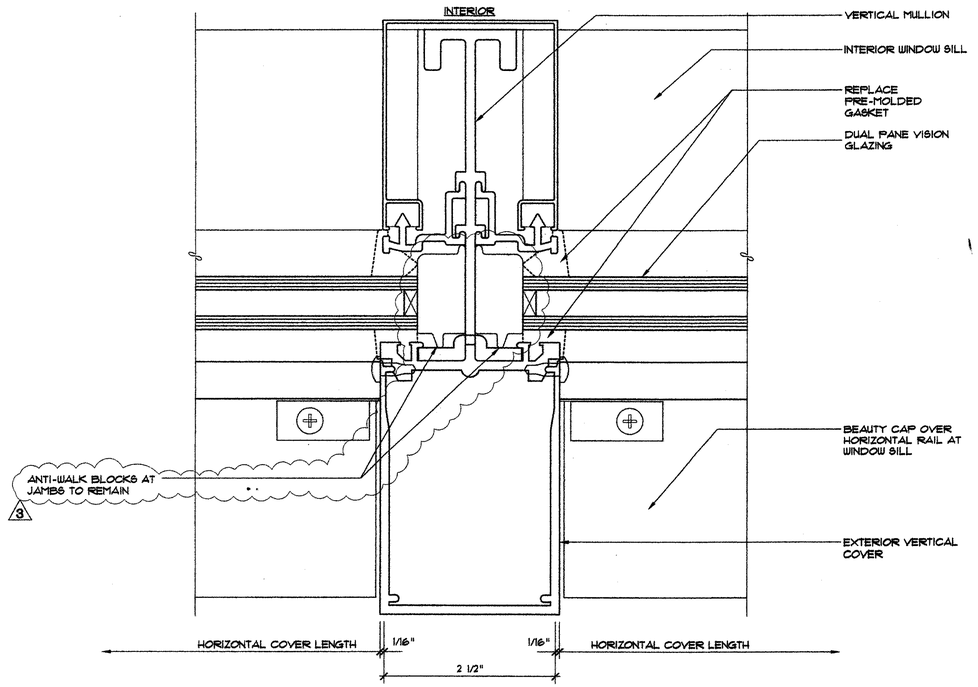
NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #1	04.03.06
	CONSTRUCTION SET	04.19.06

Sheet Title:

DETAILS

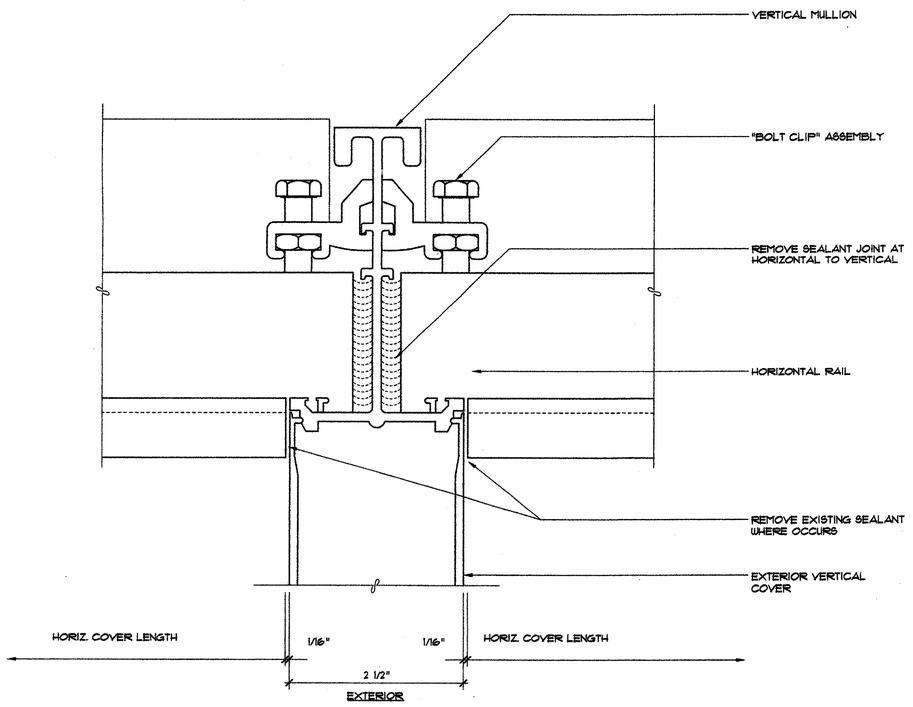
Scale:	FULL SCALE
Project #	05155.00
Date:	-
Drawn:	RR CY
Checked:	JC

A803



1E TYPICAL MULLION AT VISION - EXISTING AND SELECTIVE DEMOLITION

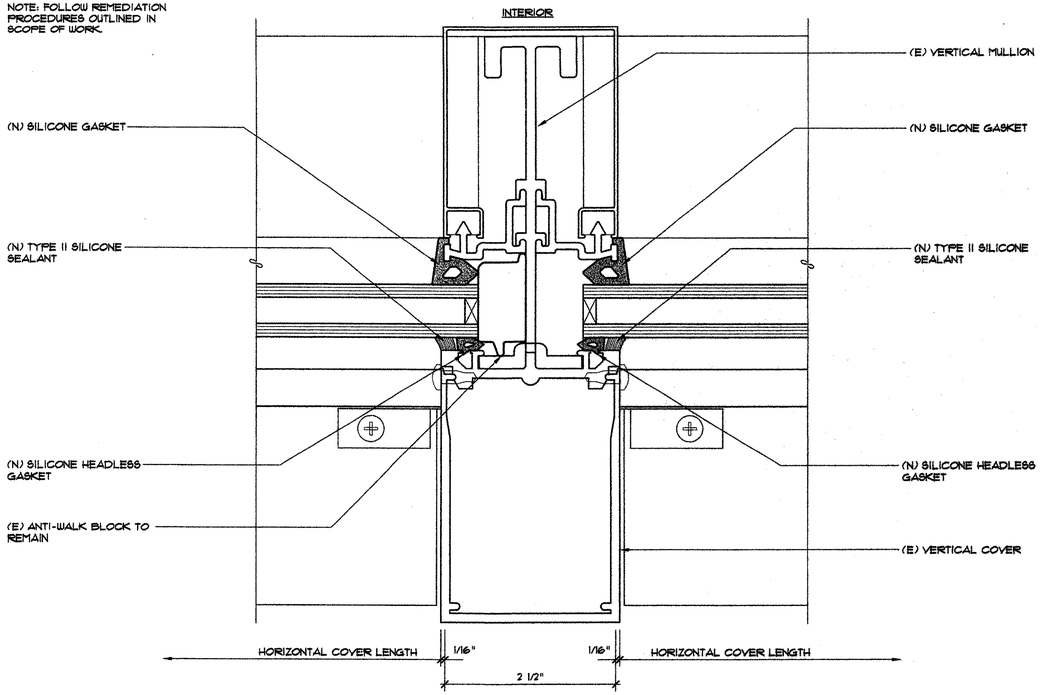
FULL SIZE



2E TYPICAL RAIL TO MULLION - EXISTING AND SELECTIVE DEMOLITION

FULL SIZE

NOTE: FOLLOW REMEDIATION PROCEDURES OUTLINED IN SCOPE OF WORK.

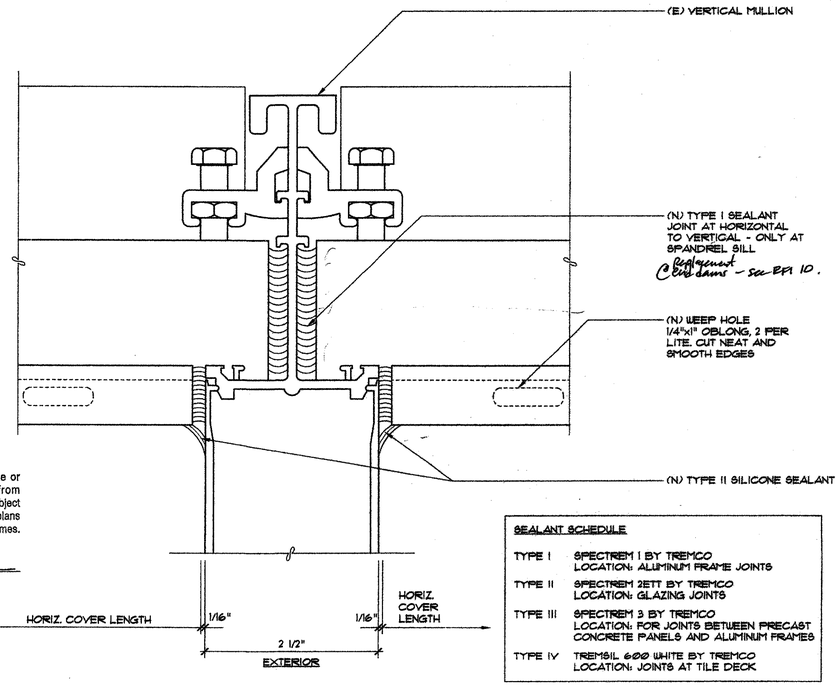


1 TYPICAL MULLION AT VISION - REMEDIATION

FULL SIZE

RFI #10 - Fully remove all sealant at the "end dam" condition... prep metal & apply sealant per 07920.

NOTE: FOLLOW REMEDIATION PROCEDURES OUTLINED IN SCOPE OF WORK.



OFFICE OF STATE FIRE MARSHAL
APPROVED
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Reviewed by: 5/1/07

SEALANT SCHEDULE

TYPE I	SPECTREM 1 BY TREMCO LOCATION: ALUMINUM FRAME JOINTS
TYPE II	SPECTREM 2ETT BY TREMCO LOCATION: GLAZING JOINTS
TYPE III	SPECTREM 3 BY TREMCO LOCATION: FOR JOINTS BETWEEN PRECAST CONCRETE PANELS AND ALUMINUM FRAMES
TYPE IV	TREMSIL 600 WHITE BY TREMCO LOCATION: JOINTS AT TILE DECK

2 TYPICAL RAIL TO MULLION - REMEDIATION

FULL SIZE

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

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LaCroix Davis LLC

Mechanical & Life Safety Engineer:

MHC ENGINEERS
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PH. (415) 512-7141
FAX (415) 512-7120

Seal:

LICENSED ARCHITECT #17977 JEFF CHEN 9/30/07 STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MEIKAI HSIU CHEN #M19582 EXP. 9/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #1	04.03.06
	ADDENDUM #3	04.11.06
	CONSTRUCTION SET	04.19.06

Sheet Title:

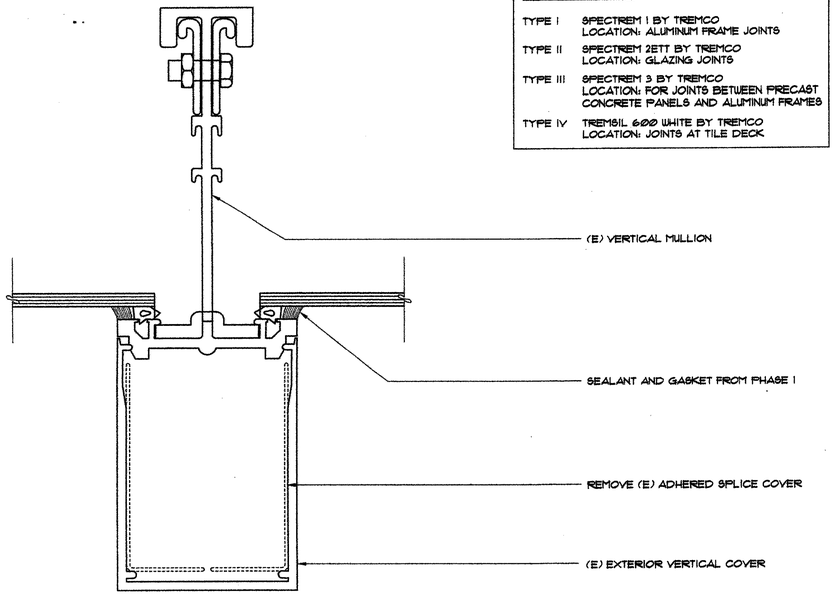
DETAILS

Scale:	FULL SCALE
Project #	05155.00
Date:	-
Drawn:	RR CY
Checked:	JC

A804

05155 - A800-807
Apr 19, 2006 - 4:49pm

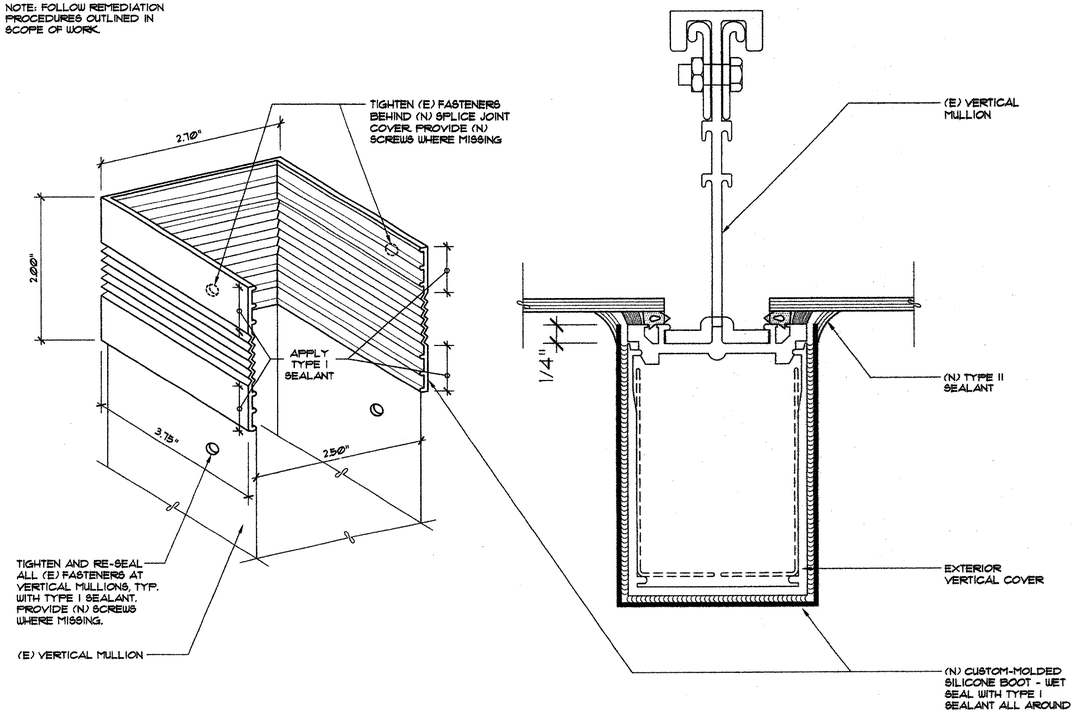
SEALANT SCHEDULE		
TYPE I	SPECTREM 1 BY TREMCO	LOCATION: ALUMINUM FRAME JOINTS
TYPE II	SPECTREM 2ETT BY TREMCO	LOCATION: GLAZING JOINTS
TYPE III	SPECTREM 3 BY TREMCO	LOCATION: FOR JOINTS BETWEEN PRECAST CONCRETE PANELS AND ALUMINUM FRAMES
TYPE IV	TREMSIL 600 WHITE BY TREMCO	LOCATION: JOINTS AT TILE DECK



1E TYPICAL VERTICAL SPLICE JOINT - EXISTING AND SELECTIVE DEMOLITION

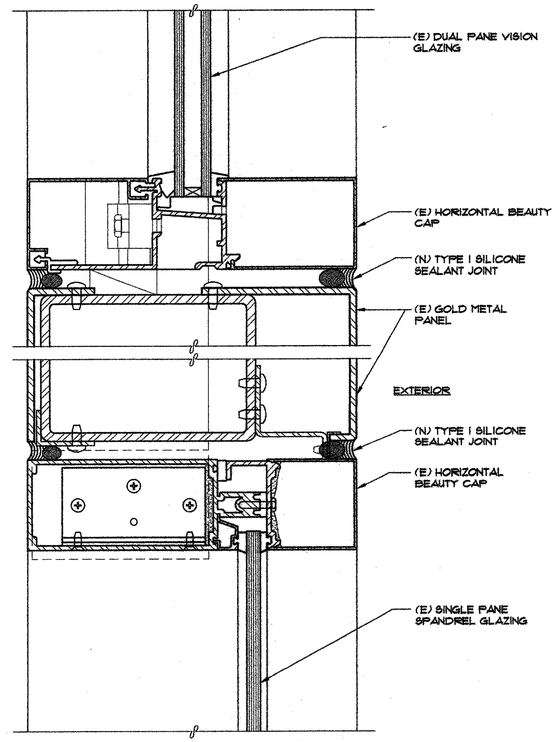
FULL SIZE

NOTE: FOLLOW REMEDIATION PROCEDURES OUTLINED IN SCOPE OF WORK.



1 TYPICAL VERTICAL SPLICE JOINT - REMEDIATION

FULL SIZE



2 STOREFRONT - REMEDIATION

HALF SIZE

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Reviewed by: 5/3/07

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

CLIENT:

State of California
Department of General Services
Real Estate Services Division
707 Third Street Suite 3-305
West Sacramento, CA 95605
Phone: (916) 376-1700

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ARCHITECTS | ENGINEERS
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Environmental Forensics:

LaCroix Davis LLC

Mechanical & Life Safety Engineer:

MHC ENGINEERS
150 9TH STREET
SAN FRANCISCO, CA 94103
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Seal:

LICENSED ARCHITECT JEFF CHEN #17977 9/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MENG-KSIU CHEN M19582 EXP. 9/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
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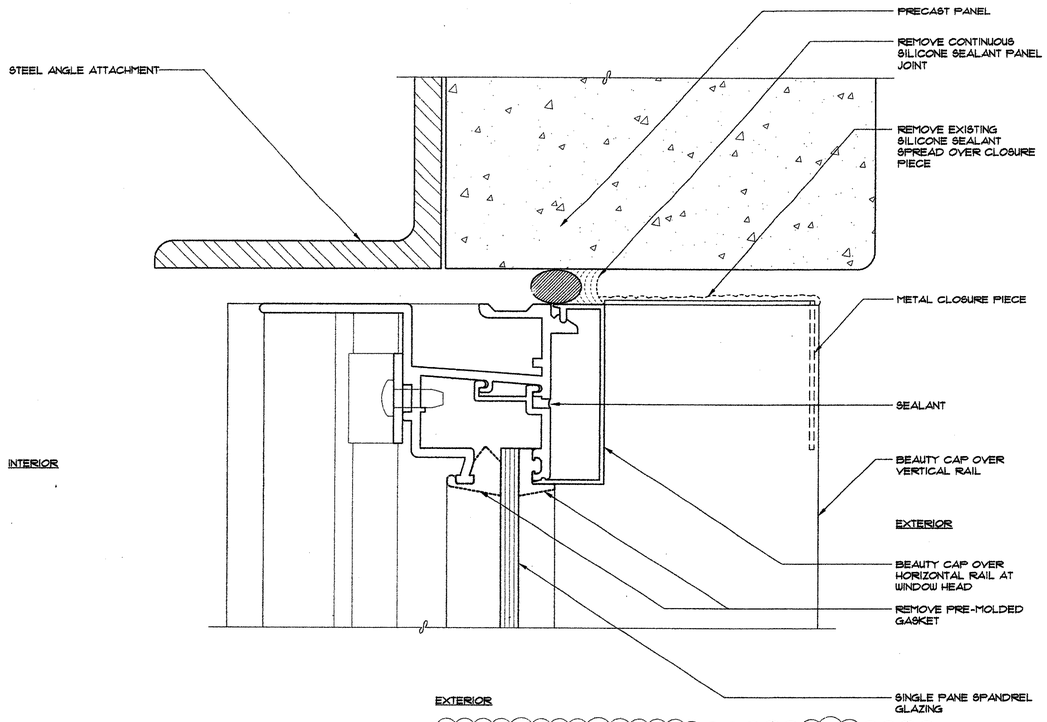
A805

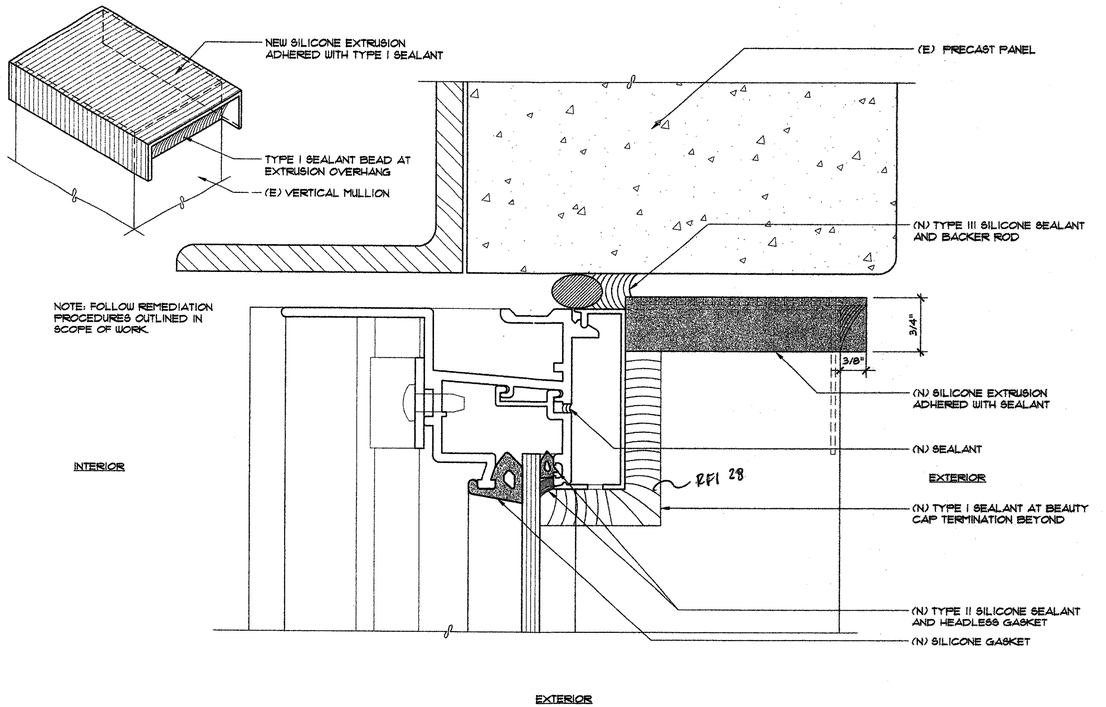
Apr 19, 2006 - 11:58am 05155-A800-807



1E TYPICAL HEAD AT PRECAST - EXISTING AND SELECTIVE DEMOLITION

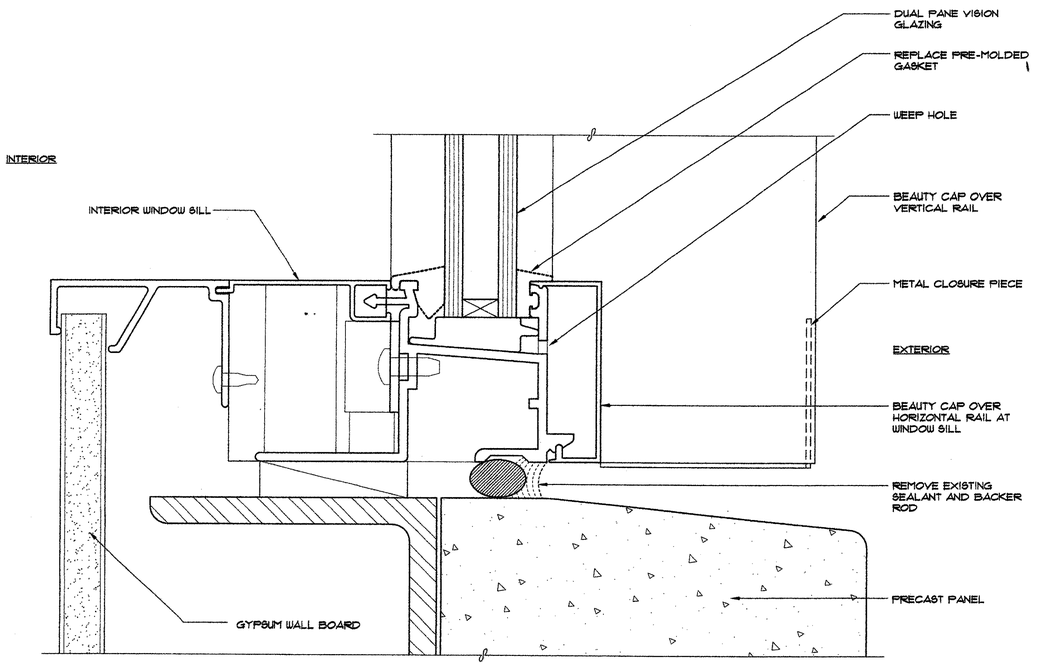
1

FULL SIZE



1 TYPICAL HEAD AT PRECAST - REMEDIATION

FULL SIZE



2E TYPICAL SILL AT PRECAST - EXISTING AND SELECTIVE DEMOLITION

1

FULL SIZE

SEALANT SCHEDULE

TYPE I	SPECTREM 1 BY TREMCO LOCATION: ALUMINUM FRAME JOINTS
TYPE II	SPECTREM 2ETT BY TREMCO LOCATION: GLAZING JOINTS
TYPE III	SPECTREM 3 BY TREMCO LOCATION: FOR JOINTS BETWEEN PRECAST CONCRETE PANELS AND ALUMINUM FRAMES
TYPE IV	TREMSIL 600 WHITE BY TREMCO LOCATION: JOINTS AT TILE DECK

NOTE: FOLLOW REMEDIATION PROCEDURES OUTLINED IN SCOPE OF WORK.

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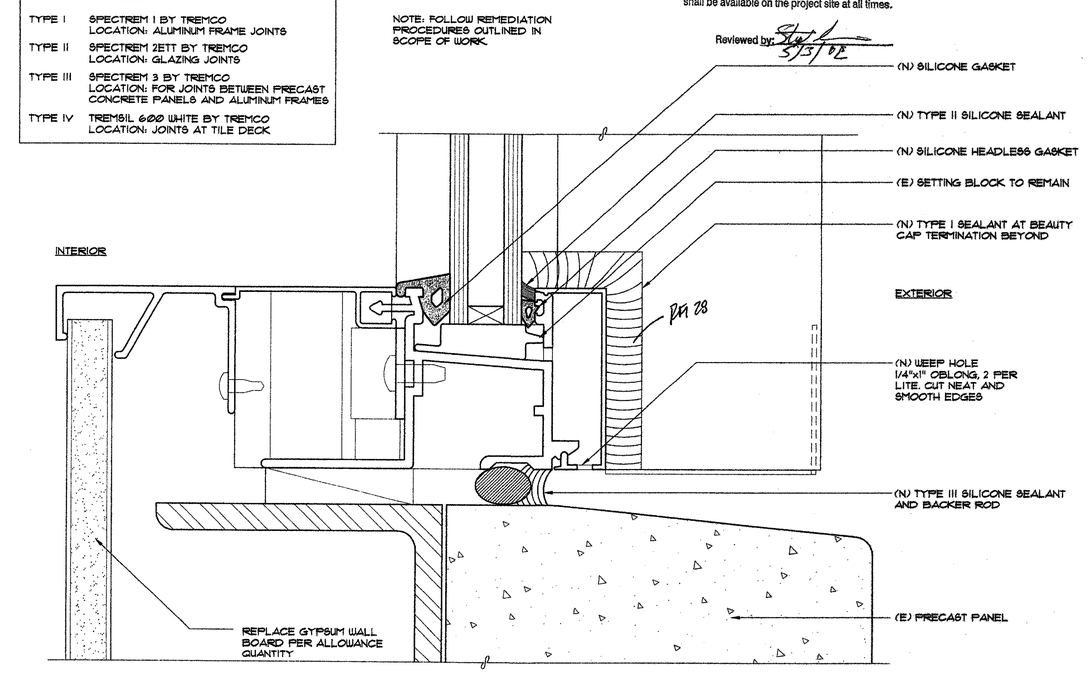

2 TYPICAL SILL AT PRECAST - REMEDIATION

FULL SIZE

450 N STREET

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SACRAMENTO, CA

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Department of General Services
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707 Third Street Suite 3-305
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Mechanical & Life Safety Engineer:

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Seal:

LICENSED ARCHITECT H-1900 JEFF CHEN # 17977 9/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER MECHANICAL M 19562 EXP. 8/31/07 STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #1	04.03.06
	CONSTRUCTION SET	04.19.06

Sheet Title:

DETAILS

Scale:	FULL SCALE
Project #	05155.00
Date:	-
Drawn:	RR CY
Checked:	JC

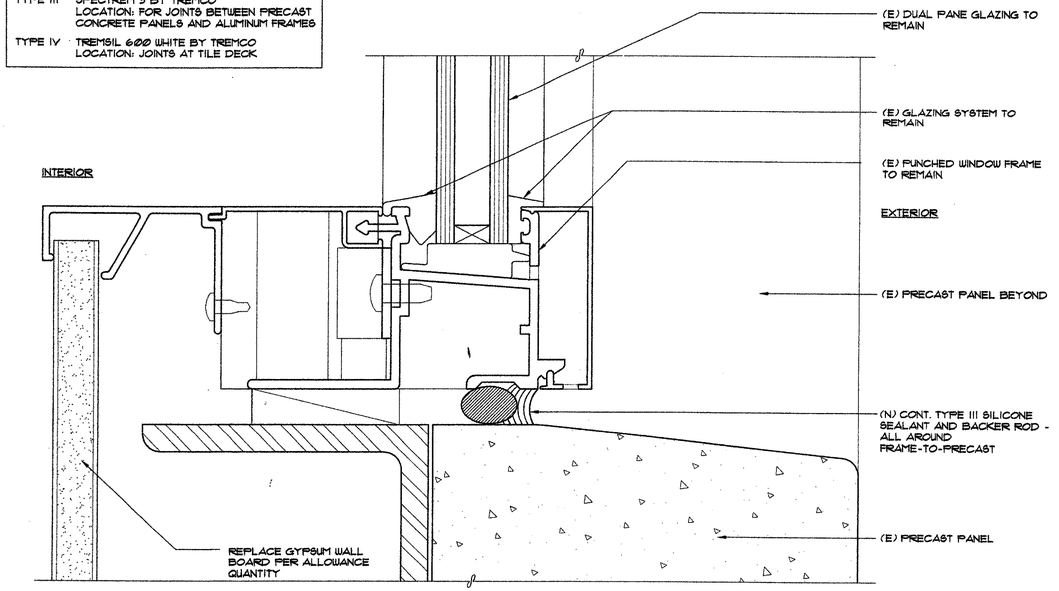
A806

05155 - A800-807
Apr 19, 2006 - 4:31pm

SEALANT SCHEDULE

TYPE I	SPECTREM 1 BY TREMCO LOCATION: ALUMINUM FRAME JOINTS	
TYPE II	SPECTREM 2ETT BY TREMCO LOCATION: GLAZING JOINTS	
TYPE III	SPECTREM 3 BY TREMCO LOCATION: FOR JOINTS BETWEEN PRECAST CONCRETE PANELS AND ALUMINUM FRAMES	
TYPE IV	TREMSIL 600 WHITE BY TREMCO LOCATION: JOINTS AT TILE DECK	

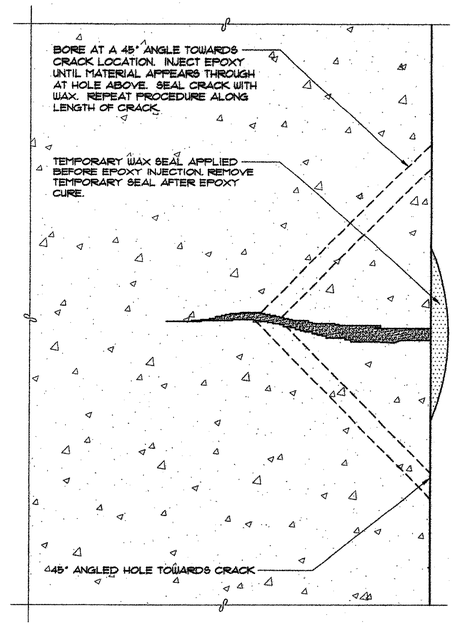
NOTE: FOLLOW REMEDIATION PROCEDURES OUTLINED IN SCOPE OF WORK.



3 TYPICAL PUNCHED WINDOW SILL AT PRECAST - REMEDIATION
HEAD AND JAMB SIMILAR

FULL SIZE

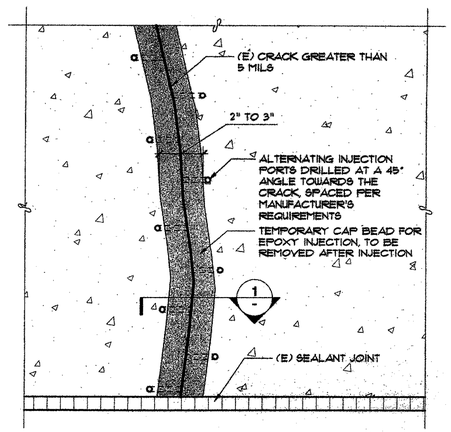
2



1 CRACK REPAIR AT PRECAST
SCHEMATIC PLAN VIEW

FULL SIZE

2



2 CRACK REPAIR AT PRECAST
SCHEMATIC ELEVATION

FULL SIZE

2

...E OF STATE FIRE MARSHAL
APPROVED
...roval of this plan does not authorize or ...prove any omission or deviation from ...plicable regulations. Final approval is subject ...field inspection. One set of approved plans ...all be available on the project site at all times.

Reviewed by: 5/6/05

Apr 19, 2006 - 11:58am 05155 - A800-807

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

CLIENT:

State of California
Department of General Services
Real Estate Services Division
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West Sacramento, CA 95605
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Mechanical & Life Safety Engineer:

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150 6TH STREET
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Seal:

LICENSED ARCHITECT YI-TSO JEFF CHEN #17977 9/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER M.ENG. HSIU CHEN M19582 EXP. 8/30/07 MECHANICAL STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
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Sheet Title:

DETAILS

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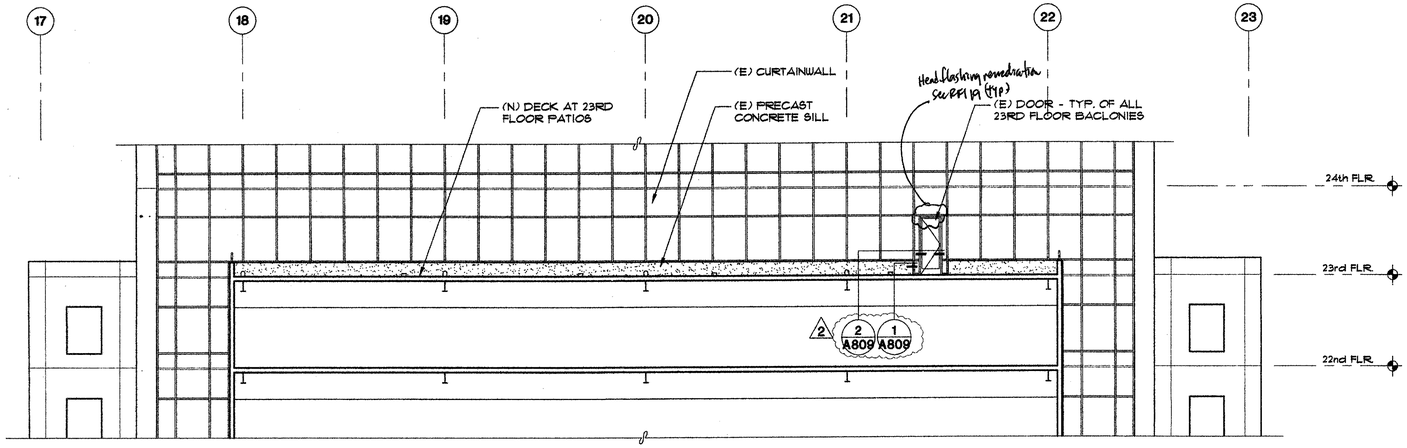
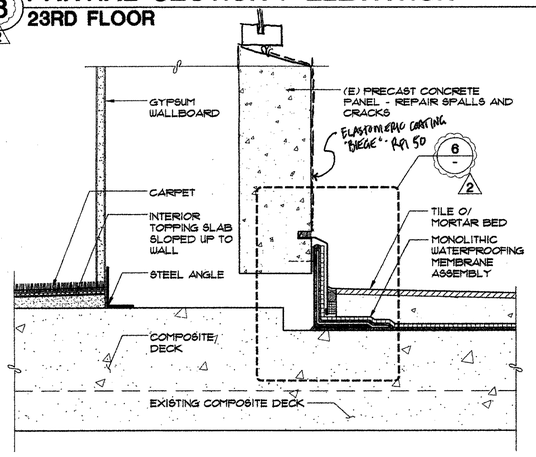
A807



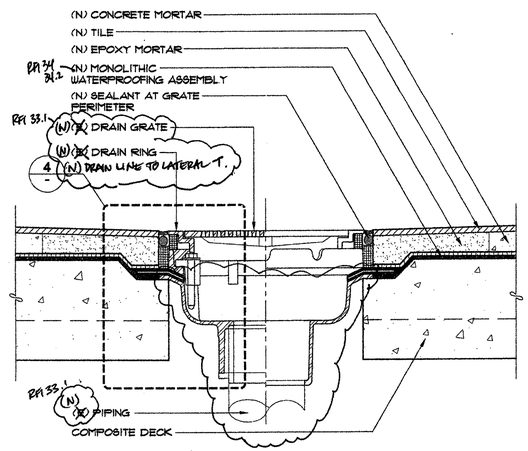
8/2 PARTIAL SECTION / ELEVATION
23RD FLOOR

3/32"=1'-0"



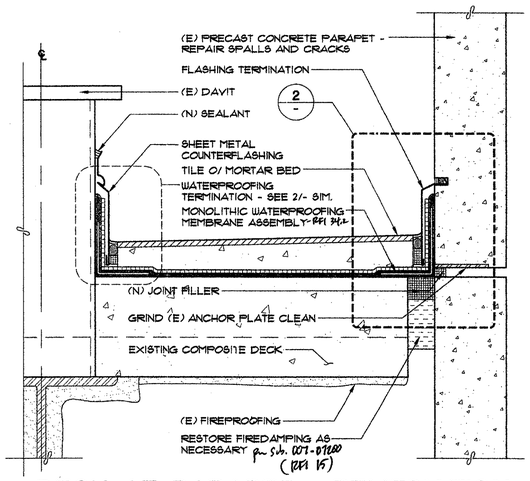
7 DECK AT WALL BASE - REMEDIAT.
23RD FLOOR

3"=1'-0"



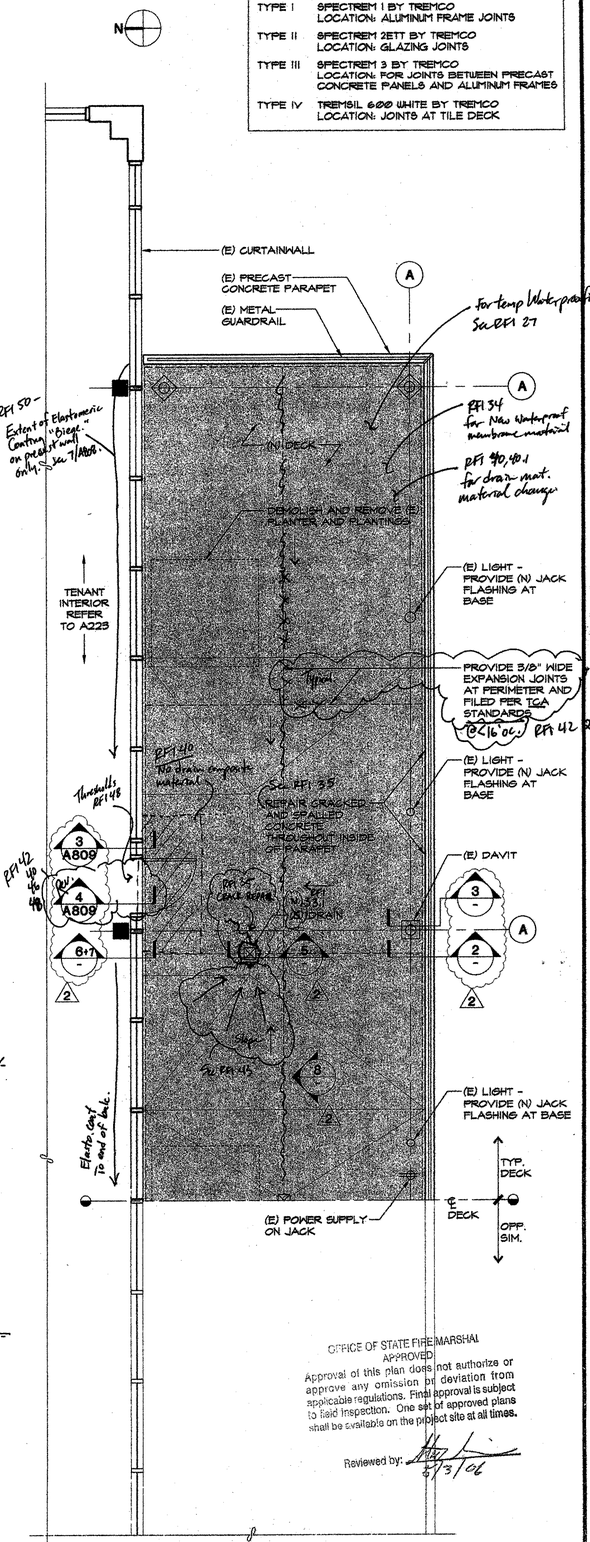
5 DECK AT DRAIN - REMEDIATION
23RD FLOOR

3"=1'-0"



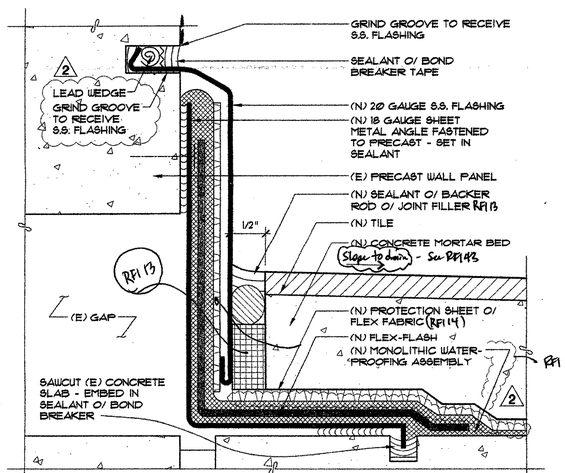
3 DECK AT PARAPET - REMEDIATION
23RD FLOOR

3"=1'-0"



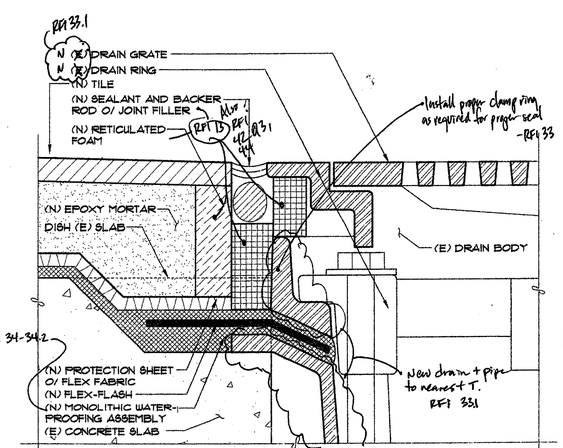
1 ENLARGED DECK PLAN
23RD FLOOR

1/4"=1'-0"



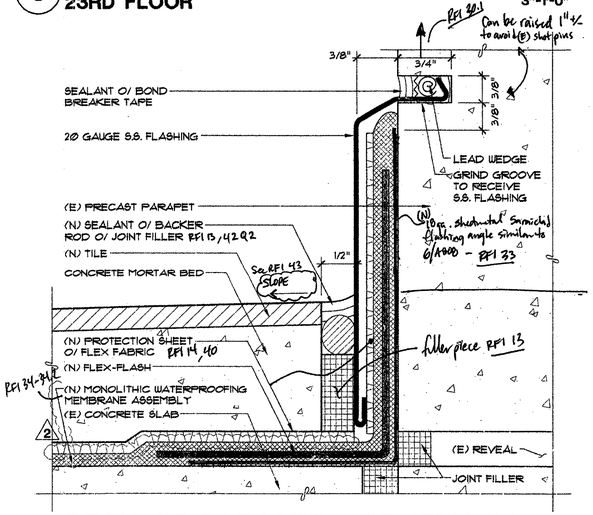
6 DECK AT WALL BASE - REMEDIAT.
23RD FLOOR

FULL SIZE



4 DECK AT (E) DRAIN - REMEDIATION
23RD FLOOR

FULL SIZE



2 DECK AT PARAPET - REMEDIATION
23RD FLOOR

FULL SIZE

SEALANT SCHEDULE

TYPE I	SPECTREM 1 BY TREMCO LOCATION: ALUMINUM FRAME JOINTS
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TYPE IV	TREMSIL 600 WHITE BY TREMCO LOCATION: JOINTS AT TILE DECK

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

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150 8TH STREET
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FAX (415) 512-7120

Seal:

LICENSED ARCHITECT YU-SO JEFF CHEN #17977 4/30/07 RENEWAL DATE STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER KEVIN K. SHU CHEN M 19582 EXP. 8/31/07 MECHANICAL STATE OF CALIFORNIA

NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #2	04.10.06
	CONSTRUCTION SET	04.19.06

Sheet Title:
DETAILS

OFFICE OF STATE FIRE MARSHAL
APPROVED
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Reviewed by: 5/3/06

Scale:	AS NOTED
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A808

Apr 19, 2006 - 11:58am 05155 - A808

SEALANT SCHEDULE

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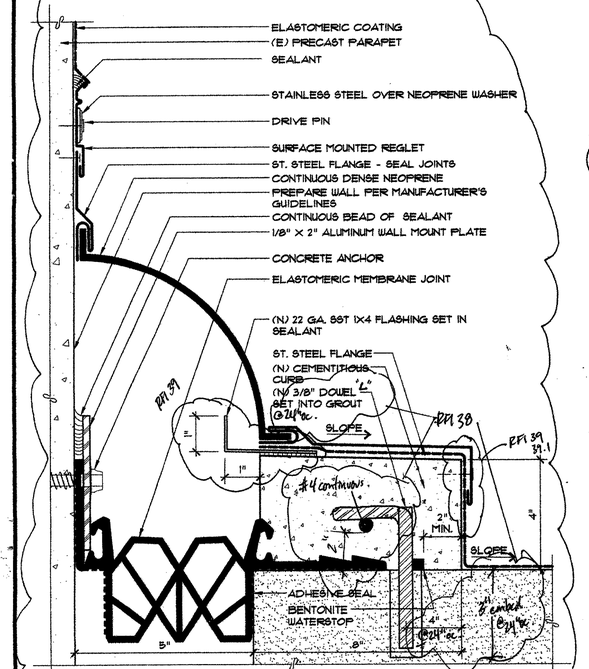
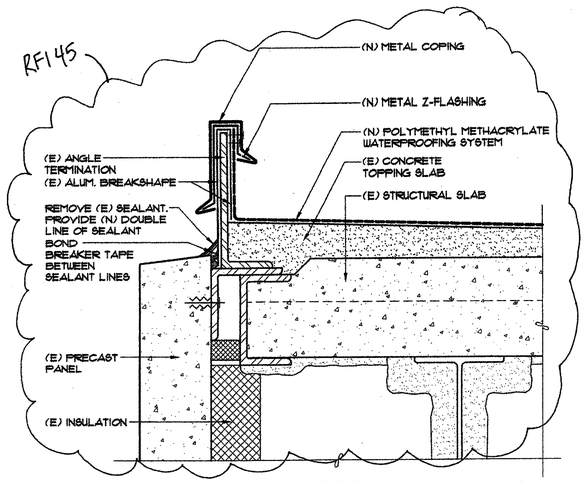
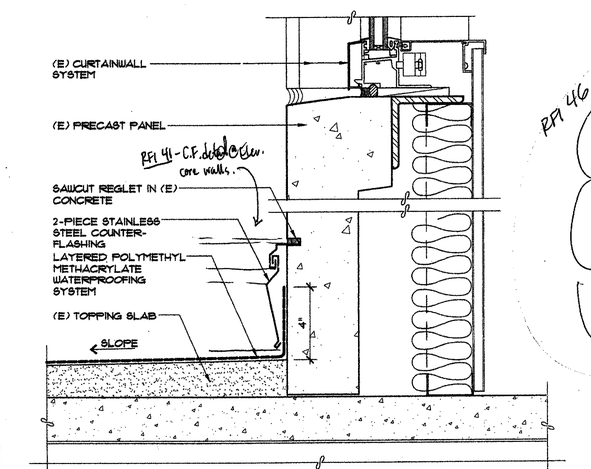
Revised RFI 32 - See detail revisions -



7 EXPANSION JOINT
GARAGE ROOF / 3RD FL BUILDING — HALF SIZE



8 DECK AT GARAGE PRECAST PANEL
GARAGE ROOF / 3RD FL BUILDING — 3"=1'-0"



6 SECTION AT PRECAST PANEL
GARAGE ROOF / 3RD FL BUILDING — 3"=1'-0"

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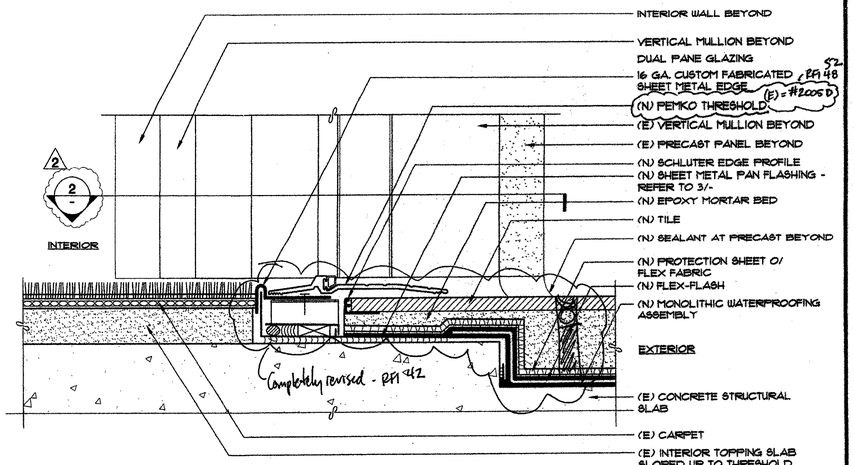
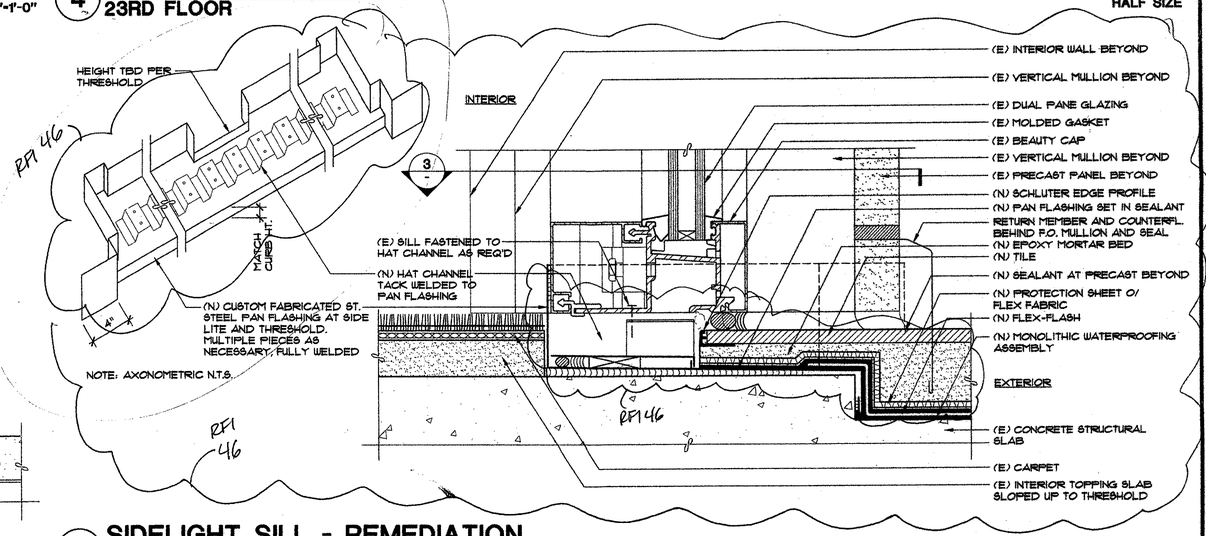
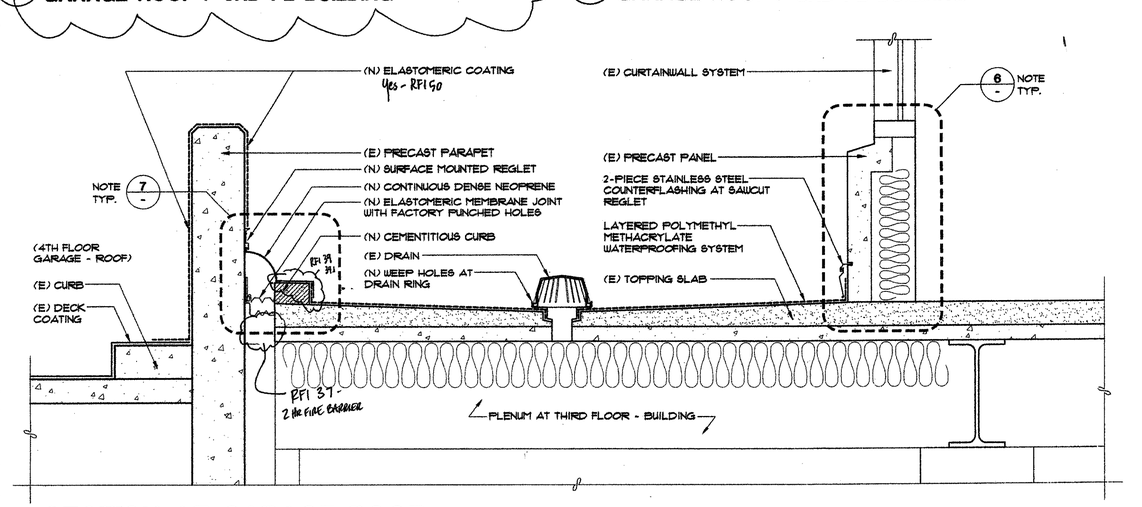
5/03/06



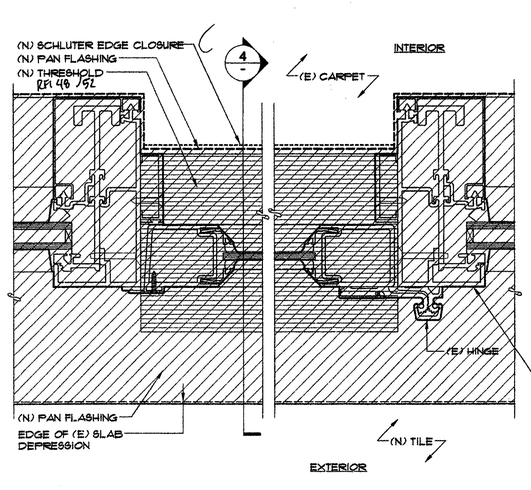
4 DOOR THRESHOLD - REMEDIATION
23RD FLOOR — HALF SIZE



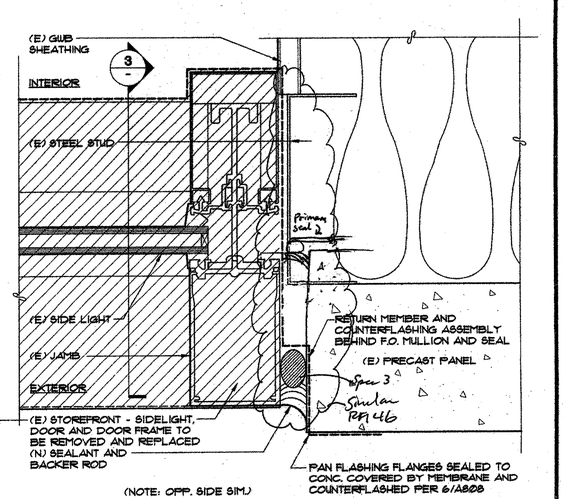
3 SIDELIGHT SILL - REMEDIATION
23RD FLOOR — HALF SIZE



5 SECTION AT GARAGE ROOF
GARAGE ROOF / 3RD FL BUILDING — 1"=1'-0"



2 PLAN AT ENTRY
23RD FLOOR — HALF SIZE



1 JAMB AT SIDELIGHT
23RD FLOOR — HALF SIZE

Oct 19, 2006 - 1:58am 05155 - A809

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

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673-3841

Seal:
LICENSED ARCHITECT
YI-YAO JEFF CHEN
#17977
9/30/07
RENEWAL DATE
STATE OF CALIFORNIA

PROFESSIONAL ENGINEER
FRANCESCO CHEN
M 19582
EXP. 9/30/07
MECHANICAL
STATE OF CALIFORNIA

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
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	CONSTRUCTION SET	04.19.06

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A809

CAPITOL SQUARE
SACRAMENTO, CALIFORNIA

C. Mineral Fiber:

1. Provide in thickness for compressing into voids for a tight friction fit when installed.
2. Provide in width sufficient to fill the depth of the void space using single width pieces.
3. Install with ends tight against terminal end construction, and with intermediate joints well compressed together and tight.
4. For vertical void spaces, provide support clips near each end, spaced not over 24 inches on center.

D. Sealants:

1. Prepare penetrations in vertical and horizontal surfaces as required to receive finish products.
2. Install damming materials as required.
3. Apply caulk or putty in accordance with manufacturer's recommendations.

E. Finish surfaces of exposed to view firestopping to a uniform and level condition.

3.04 CLEANING

A. Remove spilled and excess materials without damaging adjacent surfaces.

B. Leave finished work in neat, clean condition with no evidance of spill-overs or damage to adjacent surfaces.

END OF SECTION

4 ORIGINAL 07270 FIRESTOPPING SPEC.
P.4, BY DREYFUSS & BLACKFORD ARCH. 1"=1'-0"

CAPITOL SQUARE
SACRAMENTO, CALIFORNIA

B. Building Exterior Perimeters:

1. Provide firestopping for full depth of structural floor, filling spaces resulting where exterior facing construction continues past a structural floor or roof, see Detail. Thickness must provide required fire rating.
2. Provide whether or not there are clips, angles, plates, or other members bridging or interconnecting the exterior wall and floor systems, and whether or not such items are continuous.

C. Interior Walls and Partitions: Where the top edge of a fire-rated wall or partition abuts a fluted-type metal deck, provide firestopping to fill flute spaces for the full depth or width of the wall or partitions.

D. Penetrations:

1. Penetrations include conduit, cable, wire, pipe, duct, and other elements which pass through one or both outer surfaces of a fire-rated floor, roof, wall, or partition.
2. Fill the depth of penetrations through structural slabs, except those on grade.
3. Fill the depth of penetrations in solid type fire-rated walls or partitions.
4. Fill penetrations on both sides of hollow type fire-rated walls or partitions with thickness of firestopping required to achieve indicated rating.
5. The requirements for firestopping at penetrations apply whether sleeves have been provided or penetrations equipped with escutchaons or other trim.

E. Provide firestopping to fill miscellaneous voids or openings at fire-rated construction as specified.

3.03 INSTALLATION

A. Do not install firestopping until:

1. Cementitious fireproofing work, including repairs, has been completed.
2. Building is sufficiently enclosed or protected against adverse weather conditions.
3. Supporting framing and surrounding construction is in a dry condition.

B. Prepare and install firestopping in accordance with manufacturer's instructions.

3 ORIGINAL 07270 FIRESTOPPING SPEC.
P.3, BY DREYFUSS & BLACKFORD ARCH. 1"=1'-0"

CAPITOL SQUARE
SACRAMENTO, CALIFORNIA

1.06 PROTECTION

A. Where firestopping is installed at locations which will remain exposed in the completed work, provide protection to prevent damage to adjacent surfaces and finishes, and protect against damage by other construction operations.

PART 2 - PRODUCTS

2.01 MINERAL FIBER FIRESTOPPING

A. Type: Semi-rigid mineral fiber insulation; U.S. Gypsum "Thermafiber Safing"; Manville "Pyrofiber"; or approved equal.

B. Density: Minimum 4 pounds per cubic foot.

C. Support Clips: U.S. Gypsum "Thermafiber Safing Impaling Clips"; or approved equal; or custom designed to suit installation conditions, fabricated from galvanized sheet steel.

2.02 SEALANTS

A. Metaculk 835 as manufactured by Metalines, Inc., or approved equal.

B. 3M - penetration firestop curtain wall opening CP 25 S/L caulk, 2-hour "F" rating UL system #U900F.

PART 3 - EXECUTION

3.01 INSPECTION

A. Inspect openings and voids to be sealed to determine if conditions are satisfactory for the proper installation of firestopping. Do not commence work until unsatisfactory conditions have been corrected.

3.02 EXTENT OF FIRESTOPPING WORK

A. General: Provide solid continuous firestopping wherever the penetration or addition of a construction element through or adjacent to a fire-rated floor, wall or partition, or roof creates a discontinuity of such a rated separation. Application limited in size and configuration to approved, tested systems. Do not install insulation types specified in other Sections in lieu of specified firestopping materials.

2 ORIGINAL 07270 FIRESTOPPING SPEC.
P.2, BY DREYFUSS & BLACKFORD ARCH. N.T.S.

CAPITOL SQUARE
SACRAMENTO, CALIFORNIA

SECTION 07270

FIRESTOPPING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Provide all labor, materials, tools, services and installation of firestopping.

1.02 SUBMITTALS

A. Product Data: Manufacturer's descriptive, technical data and illustrations.

B. Submittals are not required when the specified item is to be furnished and installed with no modifications.

1.03 QUALITY ASSURANCE

A. Firestopping materials and systems shall be listed and labeled in accordance with requirements of Underwriters Laboratories, Inc. (UL) Building Materials Directory.

B. Form materials to remain in place in the completed work and sealant used for firestopping work shall be UL listed and labeled.

C. Fireproofing materials shall be rated as required when tested in accordance with ASTM E119.

1.04 JOB CONDITIONS

A. Follow manufacturer's instructions for temperature, ventilation, and other conditions for mixing and installing foam seals.

B. Observe and follow manufacturer's precautions when using materials considered toxic and hazardous.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in the manufacturer's unopened containers and packages with manufacturer's name, labels, product identification, lot numbers, and mixing and installation instructions, as applicable.

B. Store materials in unopened containers and packages, and under conditions recommended by manufacturer.

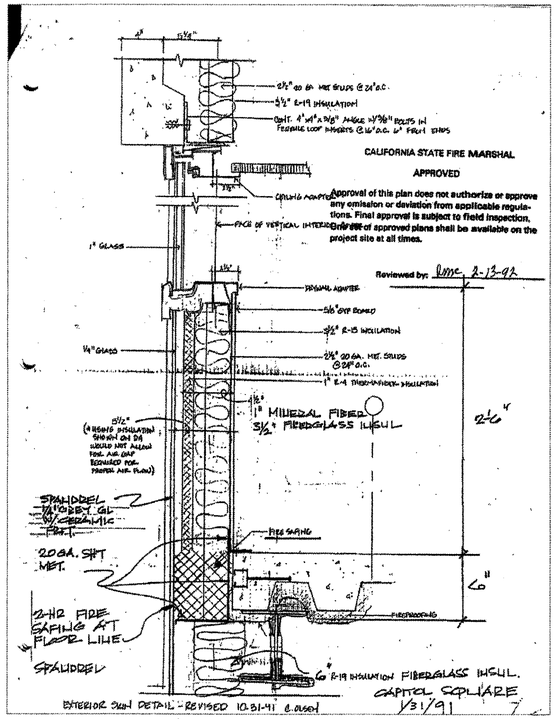
1 ORIGINAL 07270 FIRESTOPPING SPEC.
P.1, BY DREYFUSS & BLACKFORD ARCH. N.T.S.

NOTE:

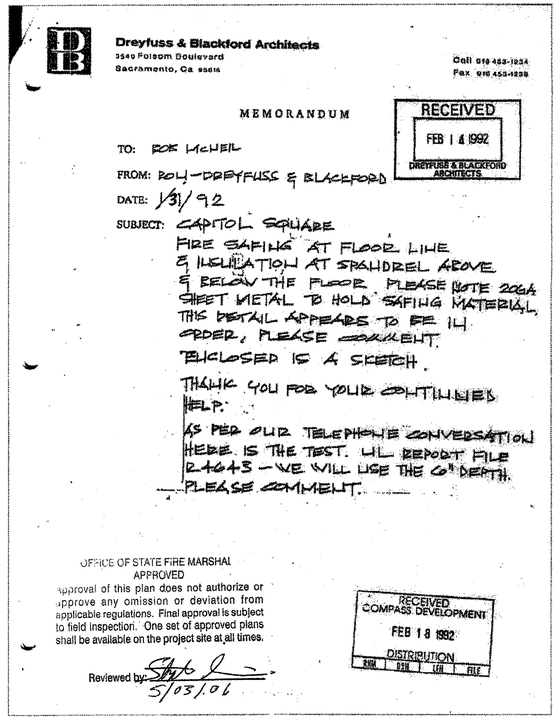
THESE DOCUMENTS ARE FROM THE PROJECT'S ORIGINAL CONSTRUCTION, AND ARE DATED FROM 1990 - 1992. THE INFORMATION PRESENT ON THESE ORIGINAL DOCUMENTS IS INTENDED SOLELY FOR INSTRUCTION TO THE CONTRACTOR FOR RE-INSTALLATION OF EXISTING FIRESTOPPING OR REPLACEMENT OF DAMAGED FIRESTOPPING TO MATCH EXISTING.

8 NOT USED

7 NOT USED



6 07270 SUBMITTAL FR. ORIG. CONSTR.
P.2, BY DREYFUSS & BLACKFORD ARCH. N.T.S.



Dreyfuss & Blackford Architects
3540 Folsom Boulevard
Sacramento, Ca 95816
Call 916 453-1234
Fax 916 453-1238

MEMORANDUM

RECEIVED
FEB 18 1992
DREYFUSS & BLACKFORD ARCHITECTS

TO: ROX MCNEIL

FROM: ROY-DREYFUSS & BLACKFORD

DATE: 1/31/92

SUBJECT: CAPITOL SQUARE
FIRE SAFING AT FLOOR LINE & INSULATION AT SPANDREL ABOVE & BELOW THE FLOOR. PLEASE NOTE 20GA SHEET METAL TO HOLD SAFING MATERIAL. THIS DETAIL APPEARS TO BE IN ORDER, PLEASE CONCURRENT.
ENCLOSED IS A SKETCH.
THANK YOU FOR YOUR CONTINUED HELP.
AS PER OUR TELEPHONE CONVERSATION HERE IS THE TEST. UL REPORT FILE R4643 - WE WILL USE THE 6" DEPTH.
PLEASE COMMENT.

OFFICE OF STATE FIRE MARSHAL
APPROVED
Approval of this plan does not authorize or approve any omission or deviation from applicable regulations. Final approval is subject to field inspection. One set of approved plans shall be available on the project site at all times.
Reviewed by: [signature]
5/03/06

RECEIVED
COMPASS DEVELOPMENT
FEB 18 1992
DISTRIBUTION
RBM | DSM | LGM | FILE

5 07270 SUBMITTAL FR. ORIG. CONSTR.
P.1, BY DREYFUSS & BLACKFORD ARCH. N.T.S.

May 03, 2006 - 10:41am 05155 - A810

450 N STREET

BOARD OF EQUALIZATION
SACRAMENTO, CA

CLIENT:
State of California
Department of General Services
Real Estate Services Division
707 Third Street Suite 3-305
West Sacramento, CA 95605
Phone: (916) 376-1700

Architect:
McGinnis Chen Associates, Inc.
ARCHITECTS | ENGINEERS
10 Nottingham Place
San Francisco, CA 94133
Phone: (415) 986-3873
Fax: (415) 296-0586

Environmental Forensics:
LaCroix Davis LLC

Mechanical & Life Safety Engineer:
MHC ENGINEERS
150 8TH STREET
SAN FRANCISCO, CA 94103
PH: (415) 512-7141
FAX (415) 512-7120

Seal:

CONSTRUCTION SET

NO.	DESC.	DATE
	BID SET	03.22.06
	ADDENDUM #2	04.10.06
	CONSTRUCTION SET	04.19.06
	BULLETIN #1	05.03.06

Sheet Title:
DETAILS

Scale:	AS NOTED
Project #	05155.00
Date:	-
Drawn:	CHY
Checked:	JC

B1 A810

Exhibit 4 – Specification Section 08800, Curtain Wall and Balcony Remediation, March 16, 2006, McGinnis Chen Architects, Inc.

1.00 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes products and applications of the glazing materials for curtainwall vision and spandrel units:

1. Custom-molded silicone gasket (interior and exterior) for curtainwall vision and spandrel units.

   a. Owner Furnished Materials:
   For Spandrel Only: Owner will furnish 17,000 linear ft. of interior gaskets, 15,000 linear ft. of exterior narrow gasket and 3,000 linear ft. of exterior wide gasket. The Contractor shall install the Owner-furnished material.
   b. Contractor shall be responsible for providing (furnishing and installing) the remaining gaskets for spandrels and all of the gaskets for vision units.
   c. Slight variation of the glazing pocket necessitates two sizes of exterior gasket: Narrow and Wide gaskets. Quantity breakdown of narrow and wide gasket sizes is as follows:

      i. Spandrel units exterior gasket: Inclusive of the Owner-furnished quantity, the spandrel lites require narrow gaskets at the 100% of both jamb vertical mullions and at 50% of head and sill horizontal rails. The remaining 50% of head and sill horizontal rails of spandrel lites requires wide gasket.
      ii. Vision units exterior gasket: The vision lites require narrow gaskets at the 100% of both jamb vertical mullions and at 75% of head and sill horizontal rails. The remaining 25% of head and sill horizontal rails of vision lites requires wide gasket.

   QUANTITY: Refer to the drawings for the extent of work and Verify in Field.

2. Setting blocks for spandrels.
   QUANTITY: Refer to the drawings for the extent of work and Verify in Field.

3. Temporary shim to isolate insulation from the glass.
   QUANTITY: Refer to the drawings for the extent of work and Verify in Field.

4. Curtainwall vision unit glass.
   QUANTITY: Provide 10 vision units replacement.

5. Curtainwall spandrel glass.
   QUANTITY: Provide 500 spandrel units replacement.

6. Create weep holes.
   QUANTITY: Refer to the drawings for the extent of work and Verify in Field.

7. Screws for vertical mullion at curtainwall.
   QUANTITY: Provide 10,000 screws.

8. Temporary Plug - Curtainwall temporary covers plug - Single piece of weatherproofing material to protect spandrel opening temporarily.

QUANTITY: Provide 500 and 10 locations of temporary plugs for replacement spandrel and vision units respectively.

9. Glass Edge Inspection for Spandrels: To be performed by Contractor.
   QUANTITY: Refer to the drawings for the extent of work and Verify in Field. Refer to Article 1.06 "Quality Assurance" for requirements.

10. De-glaze sufficient spandrel glass and vision glass to level horizontal rail with more than 3/16" height differential at rail ends. Provide temporary protection to minimize air infiltration at vision glass during rail adjustment work.
    QUANTITY: Include 50 locations where such procedure is required

11. Where repair work requires breaking existing spandrel an/or vision glass, the Contractor must notify the State (Owner) to schedule the glass-breakage work.

B. Related Section include the following:

1. SECTION 07920 JOINT SEALANTS

1.03 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

D. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

E. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.04 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Match existing glass thickness for necessary replacement. Confirm glass thicknesses by verifying existing glass products. Glass product information indicated in this section will assist in product confirmation.

1.05 SUBMITTALS

A. Submit under provision of Section 01330 "Submittal Procedures".

B. Product Data: For each glass product and glazing material indicated and other products not specified in this section but that will be used during the course of this Work: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, tested physical and performance properties, limitations, and color availability.

1. Material List: An inclusive list of required glazing products. Indicate each material and cross-reference related products and installation. Identify each material by manufacturer's catalog number and general classification.

2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and installing.

3. Include Material Safety Data Sheets, if applicable.

C. Submit Manufacturer's instructions for correct installation of the materials, including special surface preparation procedures and substrate conditions requiring special attention.

D. Samples for Verification: Custom-molded silicone boots and silicone gaskets: Submit four (4) Samples of 12-inch-long for each type of silicone boots and gaskets.

1. Allow a minimum of two (2) rounds of sample submittal for custom-molded silicone boots and silicone gaskets.

2. All silicone boots and silicone gaskets must be trial-fitted at a minimum of four (4) separate locations, distributed evenly over the full extent of the project, to verify fabrication tolerance and to determine further accommodation to account for existing construction variations.

E. Silicone Gaskets: Do not procure full quantity of silicone gaskets until final configuration of each extrusion and tapes has been trial-fitted successfully in the field and has received approval by the Architect. Refer to Article 1.02 "Summary" in this Section for the percentage of the silicone gaskets to be purchased by the Owner prior to start of construction.

F. Product Certificates: For each type of sealant, silicone boots, silicone gaskets, and accessory, signed by product manufacturer certifying that products furnished comply with requirements and are suitable for the use indicated.

G. Submit notice to inform the Owner each and every time the curtainwall glass is broken. Upon receiving approval from the Owner, proceed with de-glazing work.

H. Submit notice to the Owner prior to deglazing the curtainwall. Include description of the locations, number of curtainwall lites will be deglazed, the affected interior work space or circulation routes, duration of each process, cautions/warnings for the public and occupants, protections, and etc.

I. Submit report to document Spandrel Glass Edge Inspection as described in Article 1.06 "Quality Assurance".

J. Samples for Verification: Provide the following Samples: Submit four (4) Samples for each type of glazing material.

1. Silicone gaskets: 12" long of each type of gaskets.

2. Setting blocks.

3. Temporary shim to isolate insulation from the glass.

4. Curtainwall vision unit glass: 12-inch-square of the specified glass system and color.

5. Curtainwall spandrel glass: 12-inch-square of the specified glass system and color.

6. Screws for vertical mullion at curtainwall.

7. Temporary Plug - Curtainwall temporary covers plug: 12-inch-square.

K. Submit Qualification Data of firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information.

1. For products required to be installed by workers approved by product manufacturers, include letters of acceptance by product manufacturers certifying that installers are approved to apply their products.

L. Product Certificates: For each type of glazing materials, signed by product manufacturer certifying that products furnished comply with requirements and are suitable for the use indicated.

M. Maintenance Data: To include in maintenance manuals. Include recommendations for periodic inspections, cleaning, care, maintenance, and repair.

N. Submit Manufacturer's certification that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

O. SWRI Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.

P. Maintain one copy of each document on site.

Q. Coordinate paragraph below with qualification requirements in Division 1 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

R. Warranties: Sample of warranties specified in this Section.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; certified by manufacturer; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1. Company specializing in performing the work of this section with minimum five (5) years of experience.

2. Workers: Thoroughly skilled and specially trained in the techniques installing curtainwall glazing. Applicators shall be able to demonstrate acceptable level of skill for review and acceptance by the Architect.

3. The work crew shall consist of only approved Installers. Maintain a list of approved Installers' names for Project Record. Notify Architect for change of the work crew name list.

B. Perform work in accordance with SWRI and ASTM requirements for preparation of surface and material installation and in accordance with sealant, silicone boots, and silicone gaskets manufacturer's requirements for preparation of surfaces and material installation instructions.

C. Use adequate numbers of skilled workmen thoroughly trained and experienced in the necessary crafts and completely familiar with the specified requirements and methods needed for proper performance of the Work of this Section.

D. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten (10) years of experience. Manufacturer shall have factory-trained representatives who are available for consultation and Project site inspection at no additional cost.

E. Sealants shall be applied in accordance with Manufacturer's directions and printed specifications. Sealants applied shall be free of defects.

F. Sealant, silicone boots, and silicone gaskets shall be installed in accordance with Manufacturer's directions and printed specifications. Sealant, silicone boots, and silicone gaskets installed shall be free of defects.

G. Source Limitations for Glass: Obtain each type of glass through one source from a single manufacturer.

H. Glass Product Testing: Obtain glass test results for product test reports in "Submittals" Article from a qualified testing agency based on testing glass products.

1. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

2. Glass Testing Agency Qualifications: An independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

I. Elastomeric Glazing Sealant Product Testing: Refer to Section 07920 – JOINT SEALANTS

J. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and GANA's "Glazing Manual."

2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

K. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency:

1. Insulating Glass Certification Council.

2. Associated Laboratories, Inc.

L. Pre-installation Mock-ups: Before installation, install mock-ups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Install mock-ups to comply with the following requirements, using materials indicated for the completed Work and to demonstrate performance and constructability and set quality standards for materials and execution:

1. Install mock-ups in the location and of the size indicated or, if not indicated, request for Architect's direction.

2. Build glass mockups by installing the following kinds of glass in mockups: Repeat mockups installation until a good fit is achieved and approved by the Architect.

   a. Curtainwall vision glass.
   b. Curtainwall spandrel glass.

3. Build mock-up under provisions of Section 01400 "Quality Requirements".

4. Mockup shall be tested for adhesion.

5. Perform water tests at spandrels and vision units as described in Article 3.08 "Field Quality Control" in this Section.

M. Pre-installation Mock-ups: Before installation, install mock-ups for each joint sealant, silicone boots, and silicone gaskets to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Install mock-ups to comply with the following requirements, using materials indicated for the completed Work and to demonstrate performance and constructability and set quality standards for materials and execution:

1. Joints in mockups of assemblies specified in other Sections that are indicated to receive joint sealants, which are specified by reference to this Section.

2. Install mock-ups in the location and of the size indicated or, if not indicated, request for Architect's direction.

3. Repeat mockup installation until a good fit is achieved and approved by the Architect.

4. Silicone Boots and Silicone Gaskets Mock-ups:

   a. Take sufficient field measurements to establish upper and lower limits of each dimension associated with each silicone boots and silicone gaskets. Ensure that Manufacturer's representative of preformed silicone profiles is present to participate in, or to observe, the collection of field dimensions
   c. Submit preliminary shop drawing detailed profiles and dimensions, to the Architect to review for conformance with the design intent.
   d. After approval of the preliminary shop drawings, produce limited but sufficient number of initial extrusions for trial-fitting in the field.
   e. Conduct trial fitting with representatives from the Contractor, the fabricator, and the Architect. Record dimension adjustments or configuration changes as necessary to fit project conditions.
   f. Reflect adjustments on shop drawings and submit to the Architect for review.
   g. Produce second generation extrusions, as necessary, for trial fitting in the field.

   h. Repeat trial fitting until a good fit is achieved and approved by the Architect.

5. Build mockup under provisions of Section 01400 "Quality Requirements".

6. Mockup shall be tested for adhesion.

N. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section 01310 "Project Management and Coordination".

1. Before installing sealants, meet with representatives of authorities having jurisdiction, manufacturer's technical representative, Owner, Architect, consultants, independent testing agency, and other concerned entities. Review requirements for glazing. Notify participants at least seven days before conference

O. All Work shall be subject to acceptance by the Owner and Architect. All Work that does not comply with the intent of the specifications shall be corrected by the Contractor.

P . Spandrel Glass Edge Inspection:

1. Perform glass edge inspection for each spandrel glass prior to the reinstallation of each spandrel glass. Do not rely on glass inspection just after the glass removal. Re-inspect glass edge just before installation if glass has been stored for a period of time before the reinstallation.

2. Refer to the PPG Glass Technology Guidelines attached at the end of this Section for acceptable glass edges.

3. Replace spandrel glass if any edge of the glass contains non-acceptable glass edge conditions.

4. Submit record for spandrel glass replacement. Record glass replacement by documenting date, replacement location (which elevation, which floor, and which lite), number of non-acceptable glass edge conditions, number of defective edges, photographs, and the name of the mechanic recording the data and/or performing the replacement work.

5. Save the rejected glass intact for the States' review and confirmation of glass edge defect(s). Once confirmed, the Contractor shall dispose off the glass.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles bearing manufacturer's name and label and the following information:

1. Manufacturer's brand name and stock number.

2. Product name or title of material.

3. Directions for storage and handling instructions and precautions.

4. Date of manufacture.

5. Color name and number.

B. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

C. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

D. Safety: Refer to all applicable data, including, but not limited to MSDS sheets, PDS sheets, Product labels, specific instructions for specific personal protection requirements.

E. Environmental requirements: Proceed with work of this section only when existing and forecasted weather conditions will permit the application to be performed in accordance with the manufacturer's recommendations.

F. Take precautionary measures and store in UL listed storage locker to protect from fire hazards and spontaneous combustion.

G. Remove all materials, including cloths, tarps, and empty containers from the area of Work at the close of each day.

1.08 REGULATORY REQUIREMENTS

A. Conform to applicable federal, state, and local regulatory requirements including flame and smoke rating requirements for finishes.

B. Flammable Liquids serve all current regulation regarding flammable liquids such as posting "No Smoking" signs. Allow no open flames, welding, or other ignition sources in the Work.

C. Conform to all applicable laws, codes, and regulations for disposal of all materials, debris, and containers.

D. Comply with local regulations controlling use of volatile organic compounds (VOCs).

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1.10 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Installer's Warranty: Installer's standard written form in which Installer agrees to repair or replace glazing materials that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five (5) years from date of Substantial Completion.

C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: Ten (10) years from date of Substantial Completion.

2. Warranty Period for silicone boots and silicone gaskets: Twenty (20) years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.

1. Setting Blocks: Furnish Owner not less than Twenty (20) sets.

2. Silicone boots: Furnish Owner not less than Fifteen (15) of each type of silicone boots.

3. Silicone gaskets: 100 linear feet for each type of silicone gaskets.

4. Include Label indicating Product and Manufacturer's information.

2.00 PRODUCTS

2.01 PRODUCTS AND MANUFACTURERS

A. Products: Subject to compliance with requirements.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: Match the existing adjacent wall color or existing sealant or submit for approval.

2.03 GLASS PRODUCTS

A. Vision Unit Glass: Match existing. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.

1. Provide 1" Insulated Glass: Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.

a. Inside Lite: 1/4" gray HS (heat-strengthened), Low-E.
b. Spacer Specifications: Manufacturer's standard spacer material and construction: 1/2" air space.
c. Outside Lite: 1/4" Clear annealed glass. ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated. Ultra-Clear (Low-Iron) Float Glass: Class I (clear); with a minimum 91 percent visible light transmission and a minimum solar heat gain coefficient of 0.87.

2. Products:

   a. Match existing product.
   b. Manufacturer: Oldcastle, Inc. (Formerly Tempglass, Inc.) or approved equal.

B. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B (spandrel glass, one surface ceramic coated), Type I (transparent flat glass), Quality-Q3, and complying with other requirements specified.

1. Fallout Resistance: Provide spandrel units identical to those passing the fallout-resistance test for spandrel glass specified in ASTM C 1048.

2. Provide 1/4" monolithic, HS (heat-strengthened) surface stress 6080 psi ± 500 psi, ceramic frit coating on interior face.

3. Products:

   a. Match existing product.
   b. Manufacturer: Oldcastle, Inc. (Formerly Tempglass, Inc.) or approved equal.

2.04 CUSTOM-MOLDED SILICONE BOOTS AND SILICONE GASKETS

A. Provide silicone profiles in size and shape as indicated in the drawings. All preformed silicone profiles shall be molded in a continuous one-piece profile.

B. Select from one of the following Manufacturers:

1. Silicone Dense Rubber Extrusions as manufactured by Tremco Inc. Custom profiles as shown in drawings. Silicone sealant adhesive to be the same color as the extrusion color and of the type recommended by Tremco Inc.

2. Silicone Dense Rubber Extrusions by Tremco. Comply ASTM C1115, Type C.

   a. Durometer Shore A hardness for silicone gaskets: 70.
   b. Durometer Shore A hardness for silicone boots: 40.

2.05 GLAZING SEALANTS

A. Refer to Section 07920 – JOINT SEALANTS

2.06 OTHER GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks and Anti-walk Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Temporary shim: Shims or continuous extrusions with a Shore, Type A durometer hardness required by glass Manufacturer to maintain glass lites in place and to isolate the insulation from the glass lites as shown on the Construction Drawings.

2.07 WEEP HOLES

A. Create weep holes as shown on Construction Drawings. Two weep holes per lite at curtainwall.

1. Shape of Weep Holes: 1/4"x1" oblong.

2.08 MULLION ACCESSORIES

A. Provide stainless steel screws for existing curtainwall mullion. Verify screws size and models to match existing product.

2.09 TEMPORARY PLUGS

A. Provide Temporary Plugs - Curtainwall temporary covers plugs - Single piece of weatherproofing material to protect each curtainwall opening. Provide finish paint to match, as close as possible, to the color of existing spandrel glass and vision unit glass. Refer to Section 09912 "Painting" for paint product requirements.

3.00 EXECUTION

3.01 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.

2. Presence and functioning of weep system.

3. Minimum required face or edge clearances.

4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.03 DE-GLAZE AND BROKEN GLASS, GENERAL

A. Comply with the deglaze instructions from the manufacturer of the existing curtainwall system.

B. Notify the Owner immediately for any broken glass. Broken glass shall be safely removed completely from the site.

C. Handling broken glass - de-glazer should wear thick protective gloves, safety goggles, or other protections approved by the manufacturer.

D. Broken glass should be contained completely in order to protect public safety.

E. Refer to Article 1.05 "Submittals" for reporting deglaze and broken glass. Upon receiving approval from the Owner, proceed with deglaze work.

F. Dispose broken glass at area permitted by the Owner.

3.04 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.05 CURTAINWALL MULLION

A. Inspect existing curtainwall mullion screws to ensure that the screws are tightened to the manufacturer's instructions.

B. Install new screws to replace missing screws of the existing curtainwall mullion.

C. Provide washers to isolate dissimilar metals and to prevent galvanic action.

3.06 INSTALLATION OF CUSTOM-MOLDED SILICONE BOOTS AND GASKETS

A. Sight line of silicone boots and silicone gaskets shall not vary more than 1/8" in 10-feet run, or equivalent tolerance thereof. Mask along the length of the joint with tape as necessary to achieve uniform line.

B. Install silicone sealant adhesive on either side of the joint providing a minimum of 5/16" bonding surface on each side of joint.

C. Within ten (10) minutes of sealant application, embed silicone boots or gaskets as shown on the drawing. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both silicone boots/gaskets and substrates. Make certain the adhesive "bleeds-out" along entire perimeter of extrusion.

D. Remove excess sealant adhesive while wet, and tool neat against silicone boots or gaskets Final tooling shall leave no more than 1/16" of sealant adhesive outboard of the silicone boots or gaskets.

3.07 INSTALLATION OF SILICONE GASKET

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

3.08 FIELD QUALITY CONTROL

A. The contractor for work under this section shall maintain a quality control program specifically to verify compliance with this specification.

B. Water Tests:

1. Perform water tests at spandrels and vision units per the standard of ASTM E1105 (with negative pressure): Set up tests so that each test include the entire spandrel/vision unit system as a test specimen.

2. Perform water test at window sill track per the standard of AAMA 502. Perform sill track water test after the creation of weep holes at curtainwall.

C. Spandrel Glass Edge Inspection: Refer to Article 1.06 "Quality Assurance" for glass inspection requirements.

D. Owner reserves the right to invoke the following test procedure at any time and as often as Owner deems necessary during the period when sealant is being applied:

1. Owner may engage a qualified independent testing agency to sample glazing materials being used. Samples of material delivered to Project will be taken, identified, sealed, and certified in the presence of Contractor.

2. Testing agency shall perform tests for characteristics specified, using applicable referenced testing procedures or, if not referenced, using tests cited in manufacturer's product data.

3. Owner may direct Contractor to stop the installation if test results show material being used does not comply with specified requirements. Contractor shall remove non-complying products from Project site, pay for testing, and reapply the specified sealants.

E. If test results show sealants do not comply with requirements, remove non-complying materials, prepare surfaces, and reapply sealants.

F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

G. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates. Refer to Section 079200 – JOINT SEALANTS.

3.09 CLEANING

A. Clean work and disposal under provisions of Section 01770 "Closeout Procedures".

B. Cleanup: At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. After completing sealants work, clean glass and spattered surfaces. Remove spattered sealant without scratch or damage adjacent finished surfaces.

C. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

D. Remove spills from adjacent surfaces. Restore to original condition or replace with new materials to the satisfaction of the Architect.

E. Contractor shall replace all materials in kind that are damaged during Work of this Section.

F. Collect waste material that may constitute a fire hazard, place in closed metal containers and remove daily from site.

G. Provide continuous dust control to protect all areas of the Work.

H. Legally dispose of debris in accordance with local, state, and federal regulations.

I. Upon completion of the Work, remove all debris and surplus items from the site.

3.10 PROTECTION

A. Protect sealant during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

B. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

C. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

D. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

E. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

F. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

G. Provide all protection necessary to protect the tenants of the building, the public, and the property, including adjacent properties, from damage as a result of the Work in this Section.

H. Provide continuous protection of all public and private property including automobiles from damage during the Work.

I. Protect work of other trades from damage. Correct damage by cleaning, repairing, replacing, and recoating as approved by Architect. Leave in an undamaged condition.

END OF SECTION 08800

GUIDELINES FOR CUT EDGE QUALITY

The as-cut quality of glass edges is the single most important factor affecting the edge strength of glass. Poor cut-edge quality can reduce the glass edge strength by 50% or even more, depending on the severity of the edge damage resulting from poor cutting techniques.

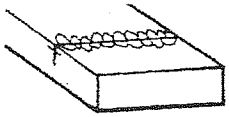
Glass edge quality, and the resulting glass edge strength, is particularly critical to the performance of the glass under thermal loading, and in applications where one or more edges is not supported (such as butt-glazing).

PPG is pleased to offer these Guidelines for Cut Edge Quality, including the representative pictures on page 2. The pictures can be used for comparative purposes to provide a relative judgement of cut edge quality.

Some Terminology

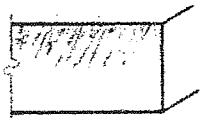
Score: The furrow made by the glass cutting tool.

Wings: Glass flakes originating on each side of the score. They may fly out under excessive cutting wheel pressure.

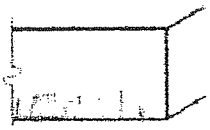


Convolutions: Smooth rolling surfaces on the glass edge - not a weakening factor.

Shark Teeth: Dagger-like imperfections which start from the score surface. The edge strength and resulting potential for glass breakage increases as the depth, roughness, and number of shark teeth increases.



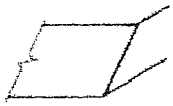
Serration Hackle: Edge imperfections, usually perpendicular to glass surface, which occur at surface opposite the score. The edge strength and resulting potential for glass breakage increases as the density and depth increases.



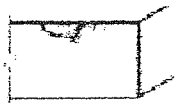
Flare: Sharp protrusion at junction of the edge and glass surface. Susceptible to further damage

GUIDELINES FOR CUT EDGE QUALITY

Bevel: An edge that is not perpendicular to the glass surfaces.



Flake Chips: Smooth shallow chips.



V-chips: Rough, penetrating chips.

Acceptable Clean-Cut Edges may have:

- ✓ Score, if wings do not fly out.
- ✓ Convolutions
- ✓ Serration Hackle, only within 6-inches of the corners.
- ✓ Flare or Bevel, if not more than 1/32-inch on 1/8-inch or thinner glass and 1/16-inch on thicker glass. Flare is not allowed where setting blocks contact the glass.
- ✓ Chips, only within 8-inches of corners and if not longer than ¼-inch across and not deeper than ½ the glass thickness.
- ✓ Run lines, if smooth and rolling.
- ✓ Frost/Rubble, a fine grain effect that is typical on the cut edge.

Borderline Edges may have all the defects acceptable for clean-cut edges plus:

- ✓ Shark Teeth, if penetration does not exceed ½ the glass thickness.
- ✓ Serration Hackle, if not deep or dense and if spalling is not present.
- ✓ Chips, if not larger than ¼" across and not deeper than ½ the glass thickness.

Some Glass Cutting Best Practices

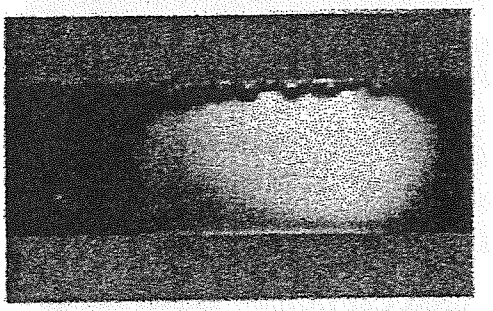
- ✓ Good housekeeping – keep area, tabletop, and equipment clean.
- ✓ Use the proper wheel for the glass thickness being cut.
- ✓ Ensure that a good quality, sharp wheel is being used.
- ✓ If cutting fluid is used, use quality fluids in the proper quantity.
- ✓ Keep cutting bridge properly aligned.
- ✓ Use proper score pressure.
- ✓ Use proper breakout procedures.

Guidelines Poster

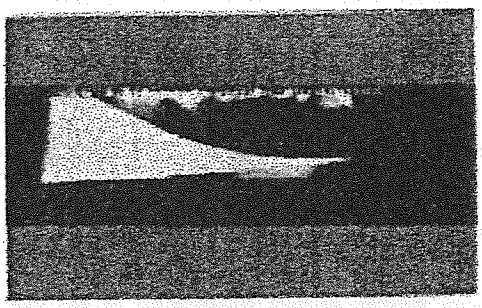
PPG Customers are invited to request a 24" x 38" poster from their account manager. The poster is intended for display in the cutting work area as a visual reference.

GUIDELINES FOR CUT EDGE QUALITY

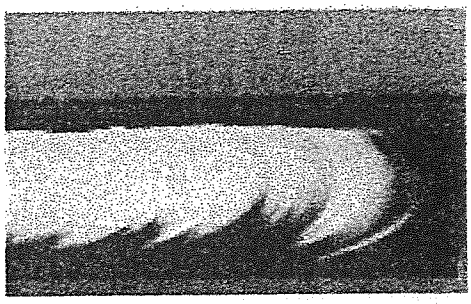
Acceptable Clean Cut Edges



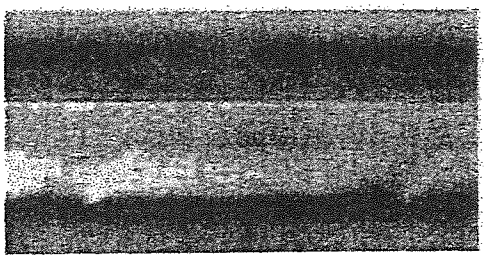
IDEAL



ACCEPTABLE - Convolutions

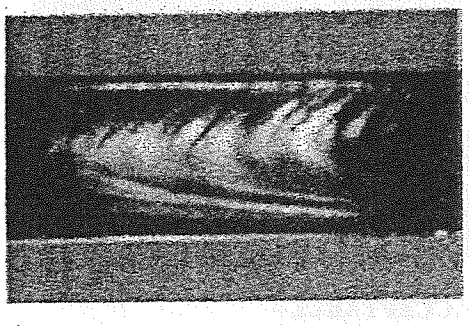


ACCEPTABLE – Run Lines

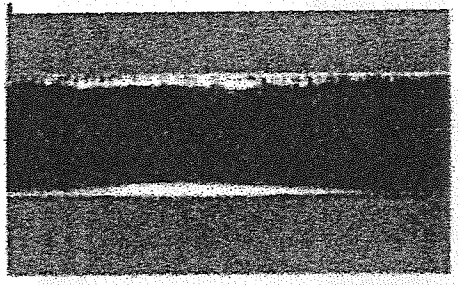


ACCEPTABLE – Frost/Rubble

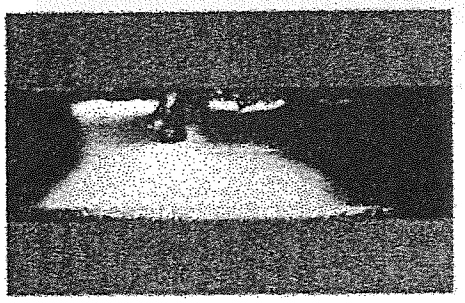
Borderline Edges



BORDERLINE – Shark Teeth

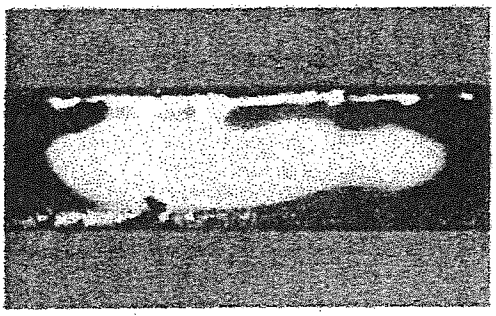


BORDERLINE – Light Serration Hackle

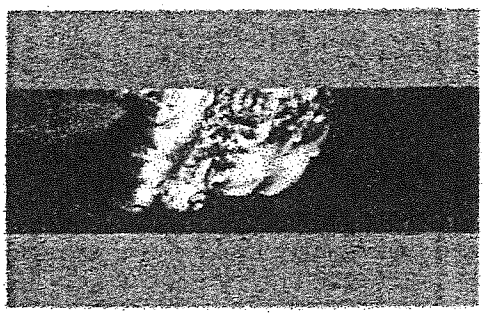


BORDERLINE – Light Serration Hackle Chips

UNACCEPTABLE EDGES



UNACCEPTABLE –
Deep Serration Hackle
Deep Shark Teeth



UNACCEPTABLE – Impact Damage

UNACCEPTABLE –
Serration Hackle with Spalls

GUIDELINES FOR CUT EDGE QUALITY

HISTORY TABLE		
ITEM	DATE	DESCRIPTION
Original Publication	10/1982	TSR-130
Revision #1	1/4/2002	Excerpts from TSR-130 to TD-119

Exhibit 5 – Letter dated January 30, 2012, from Thomas A. Schwartz and Stephen S. Ruggiero of Simpson Gumpertz & Heger to Jaffrey Martin, AIA, of McGinnis Chen Associates, Inc.

SIMPSON GUMPERTZ & HEGER
Engineering of Structures
and Building Enclosures

30 January 2012

Jeffrey Martin, AIA
McGinnis Chen Associates Inc.
2386 Fair Oaks Boulevard
Suites G & H
Sacramento, CA 95825

Project 060230 – Spandrel Glass Stress Measurement, 450 N Street, Sacramento, CA

Dear Mr. Martin:

Per your request, we have reopened the above-named project to assist with assessment of the cause of a recent spandrel glass break at the building.

Past Assignment

In 2006 you retained us to measure the residual surface compressive stress (RSCS) in spandrel glass in the building, and in certain samples of glass provided by Mr. Jeff Chen.

The results of those measurements are recorded in a letter from Simpson Gumpertz & Heger Inc. to Mr. Chen dated 27 March 2006 (copy attached). In summary:

- RSCS varied from 7,509 psi to 10,970 psi.
- RCSC average was 9,492 psi.
- RCSC varied within individual lites or samples by as much as 994 psi.

Current Assignment

You sent me photographs of a broken lite of spandrel glass and shards of glass from an area where a number of cracks emanate from a point.

The photographs show the following:

- A horizontal bar that is attached to the vertical members of the curtain wall framing and sits slightly outboard of the outside surface of the glass, casts shade onto the glass (Martin Photo 016).
- A closely spaced series of fracture lines emanate from a point in the vicinity of the horizontal bar (Martin Photo 022).
- Another confluence of fracture lines is shown in Martin Photo 005 emanating from what appears to be the sill glazing pocket.

- The spandrel insulation appears to be in contact with the inboard side of the glass (Martin Photo 033)

The fracture surfaces of the shards of glass that you sent to us show the following:

- Crushed glass at the tip of the most projecting shard. No features consistent with an origin of fracture.
- Surface roughness along the mid-plane of the glass is consistent with heat strengthened glass.
- Fracture surfaces away from the pointed end of the shards are clear and consistent with low stress fracture propagation.

Discussion

We do not have a piece of the broken glass that contains the fracture origin, so the cause of this fracture cannot be determined definitively. Possible causes of fracture, along with our assessment of the likelihood that each mechanism is active, are as follows:

- **Projectile Impact:** We cannot assess the likelihood of this cause based on the information we have.
- **Thermal stress:** The shadow cast by the horizontal bar and the insulation in contact with the inboard side of the glass can create reasonably high thermal stress. Heat strengthened glass, however, is very resistant to thermal stresses of the magnitude likely imposed by these features. Excessive thermal stress is not a likely cause of the fracture.
- **Spontaneous Fracture from Nickel Sulfide Impurity:** The RSCS measurements of the spandrel glass that we conducted in 2006 show that much of the glass has residual stress sufficient to make the glass susceptible to breakage from a Nickel Sulfide (NiS) impurity. This impurity can undergo a change in its solid state (i.e., a phase transformation), which is accompanied by slight expansion. If the particle exists near the mid-plane of fully tempered glass, or the mid-plane of highly tempered heat-strengthened glass, the particle expansion, in combination with the residual tension that exists near the mid-plane of the glass, can propagate a fracture in the glass. The phase transformation of NiS is triggered by the cumulative effect of thermal energy on the particle since the time of manufacture. The time to the phase transformation can be days to decades.
- **Excessive Bending:** We have no information to suggest that excessive wind loads (or any other lateral load imposing force) were present at the time of fracture.

Our 2006 measurements show that the spandrel glass on this building generally has high residual stresses. (Current heat strengthened glass is limited by ASTM Standards to an upper limit of 7,500 psi, many years ago the limit was 10,000 psi). This level of built-in residual stress makes this glass susceptible to NiS-generated fractures. The fact that fractures of the spandrel

glass on this building have apparently occurred over a long period of time, without any obvious external source of stress, further indicate NiS impurities as the most likely cause.

Sincerely yours,

Thomas A. Schwartz
Senior Principal

Stephen S. Ruggiero
Senior Principal
CA License No.: C 33499

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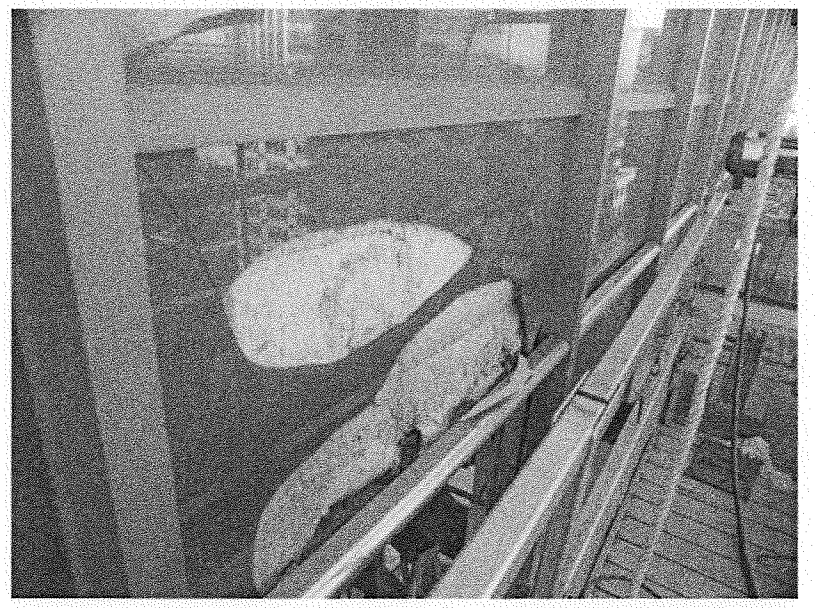
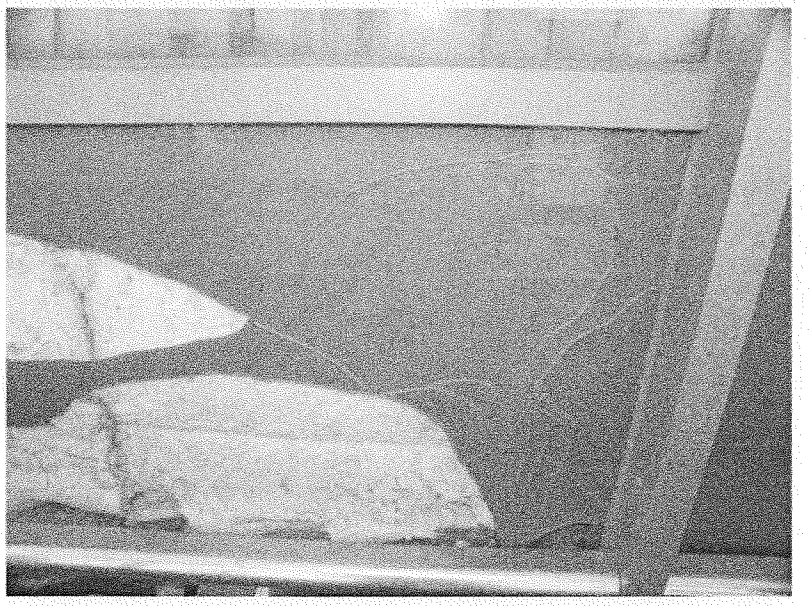


Martin Photo 016



Martin Photo 022

Martin Photo 005

Martin Photo 033

Exhibit 6 – Letter dated January 31, 2012, from Jeffry Martin, P.E., of McGinnis Chen Associates, Inc., to Joan M. Armstrong of DGS.

McGinnis Chen Associates Inc
ARCHITECTS | ENGINEERS

31 January 2012 Transmitted via E-Mail (Joan.Armstrong@dgs.ca.gov)

Joan M. Armstrong, Office Building Manager III
Department of General Services
450 N Street - Board of Equalization Building
Sacramento, CA 95814

Re: BOE Building 450 N Street (MCA Project No.: 12008.00)
Subj: January 11, 2012 Glass Breakage Report

Dear Ms. Armstrong:

This letter and attached reports from Mr. Tom Schwartz of Simpson Gumperz and Heger (SGH) contain investigation comments and findings for the January 11, 2012 spontaneous glass breakage at the Board of Equalization (BOE) Building (Project) located at 450 N Street in Sacramento. Some of the information from the January 13, 2012 Preliminary Investigation Report is included in this report.

The spandrel glass at the east elevation, 9th floor level, 5th lite from the south end of the corner (Figure 1) was reported to have broken and fallen to the ground at approximately 10:30 am (PST) on January 11, 2012. Climate conditions as reported at a private weather station at 24th and K at 10:35 am (PST) were 50°F, Dew Point of 32°F, 50% RH, skies clear and wind calm. The low temperature overnight was 32°F.

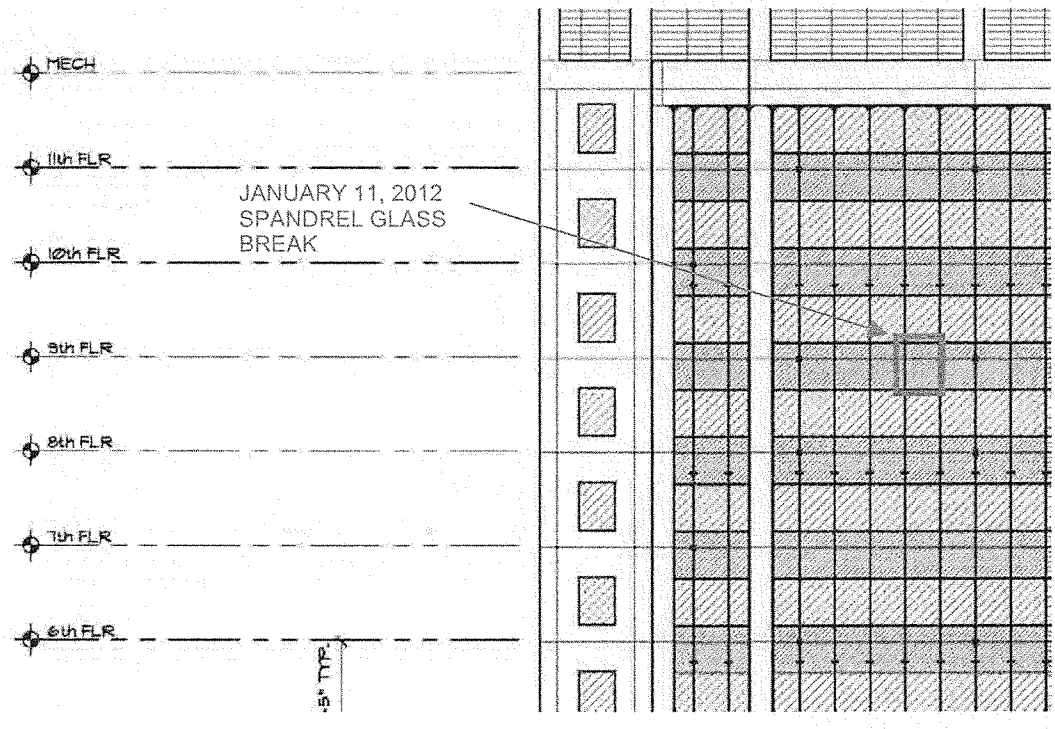


Figure 1 – Partial East Elevation

2386 Fair Oaks, 200-G PHONE 916.979.1303
Sacramento FAX 916.244.7348
California 95825 www.mcaia.com

1019 Mission Street PHONE 415.986.3873
San Francisco FAX 415.296.0586
California 94103 www.mcaia.com

MCA arrived at the site at 3:00 pm and was on site until 5:30 pm to perform a preliminary investigation for the cause of the broken spandrel glass. The opening was covered shortly after the preliminary review with plywood to close the opening and secure the remaining glass pieces from falling.

Significant portions of the glass below the floor level originally fell to the ground (Photo 1).

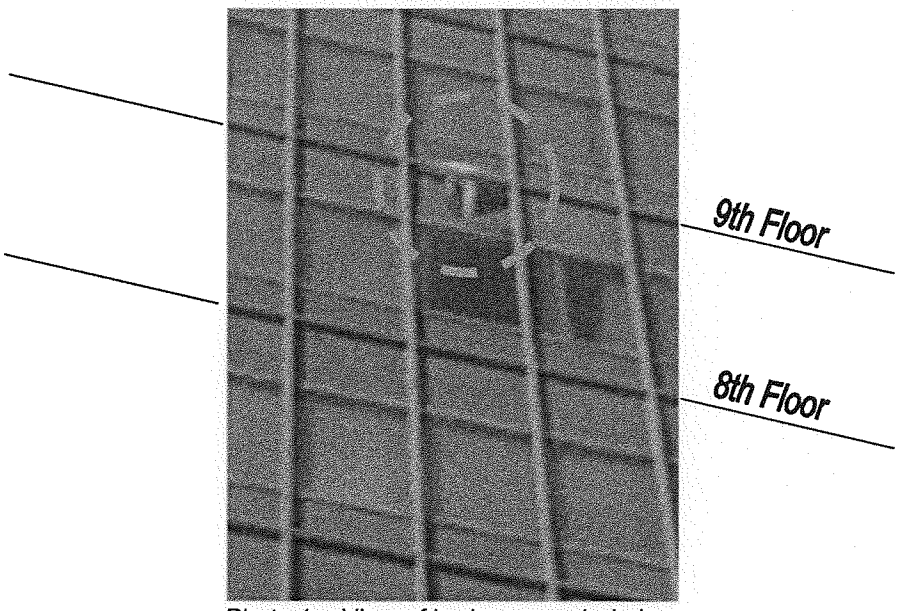


Photo 1 – View of broken spandrel glass shortly after it occurred.

Upon MCA's arrival more glass below the floor line had fallen (Photos 2 and 3) and portions above the floor line had also fallen (Photos 4 and 5).

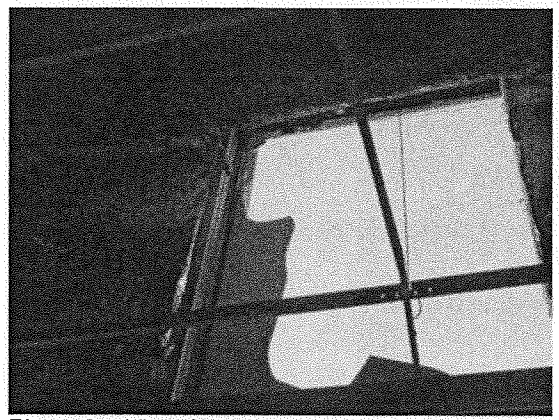


Photo 2 – View from interior of additional glass that had fallen below the floor level.

Photo 3 – View from exterior of additional glass that had fallen below the floor level.

2386 Fair Oaks, 200-G PHONE 916.979.1303
Sacramento FAX 916.244.7348
California 95825 www.mcaia.com

1019 Mission Street PHONE 415.986.3873
San Francisco FAX 415.296.0586
California 94103 www.mcaia.com

Photo 4 – View from exterior of additional glass that had fallen from above the floor line. Long arching cracks are observed in the glass.

Photo 5 – View from exterior of additional glass that had fallen from above the floor line.

Historical Summary of Glass Breaking at 450 N Street:

In September of 1999 a spandrel glass broke at this elevation. It occurred at the floor below this occurrence (curtain wall frame expansion joints are located at this level). The south elevation has had five (5) previous spandrel glass panels break; all were located at curtain wall frame expansion joint locations. The west elevation had a spandrel glass break in August of 2001; it was not located at an expansion joint location. Only one of the previous six (6) reported breaks has occurred in January (January 2005 - South elevation at 8th floor level (above the 7th floor vision glass)).

Visual Observations - January 11, 2012:

- The location of the broken spandrel glass at this floor level does not coincide with the curtain wall framing expansion joints.
- The glass is wet sealed at the exterior perimeter. A review of the glass perimeter indicates the glass has not shifted or moved since its re-installation during the exterior remediation project. The sealant is in good condition.
- The framing is not deformed or distorted. No indications that the glass became disengaged from the framing were observed.
- 20% of the glass edge along the north side below floor level was carefully checked for contact with the framing. No contact with framing was observed.
- The insulation assembly at the back side of the spandrel glass was reviewed for wear marks (frit (ceramic coating at the back side of the glass) residue from the spandrel glass) indicating vibration contact with the glass. No indications of frit residue were observed.
- No staining was observed on the exterior glass surfaces indicating long-term glass breakage.
- Both long cracks with large glass pieces and localized concentrated small breakage patterns were observed in the glass (Photos 4, 6 and 7). The localized concentrated small breakage is in the areas of more constrained edges (corner and at the horizontal bar at the floor line).

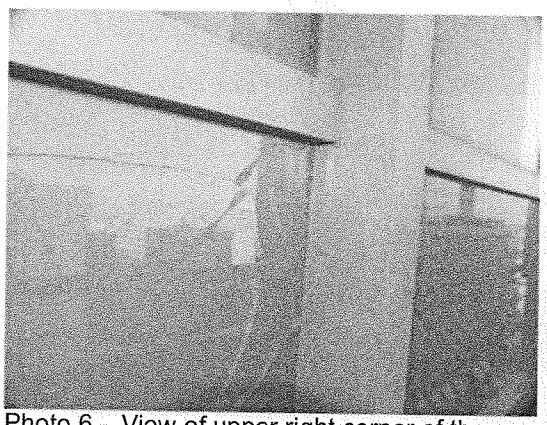


Photo 6 – View of upper right corner of the broken glass with concentrated small breaks.

Photo 7 – View of the right side of the broken glass at the floor line with concentrated small breaks that terminate to a focal point (Photo 9).

- The adjacent spandrel glass to the south of the broken lite was checked for cracks and to insure that it was secure. No cracks, or distortion in the glass was observed and the lite was secure.

MCA was provided with a small piece of the spandrel glass for further testing. One corner of the specimen contains a circular pattern (Photo 8). The original location of this sample prior to the break is unknown.

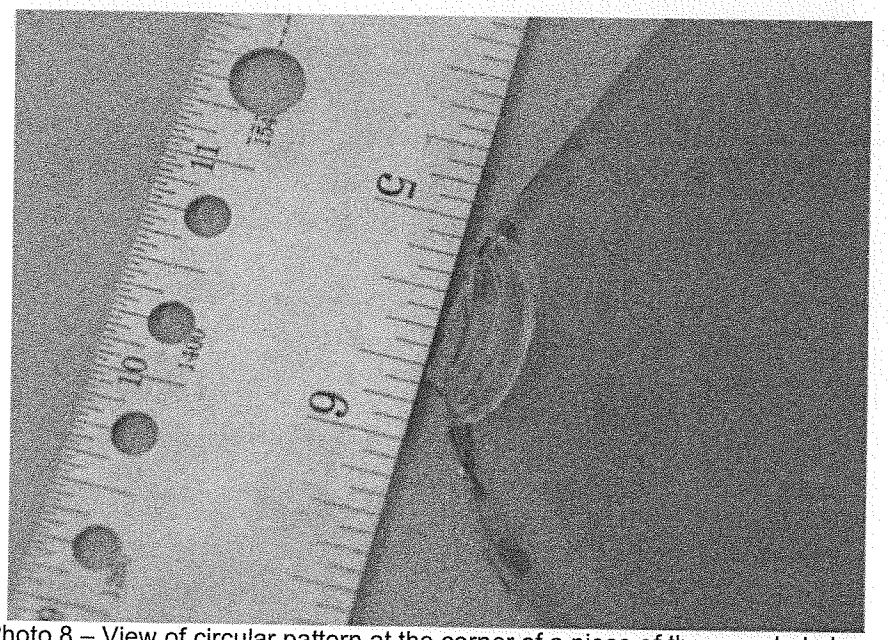


Photo 8 – View of circular pattern at the corner of a piece of the spandrel glass.

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On January 13, the sample piece provided was taken to MCA's San Francisco office to perform a strength analysis and further review of the sample piece circular pattern at the corner (Photo 8). The compressive strength was determined to be 7,500 psi using a GASP device. This result conforms to the glass type and is consistent with previous tests performed (reference attached 27 March letter.pdf).

Photos and the preliminary report were forwarded to Mr. Tom Schwartz (SGH) for further discussion and course of action to determine the cause/source of the break. The circular pattern at the corner of the glass sample was further reviewed and determined to be most likely a result of impact damage from falling. The focal point of the glass breakage pattern in Photos 7 and 9 was of interest and would be further reviewed along with edge conditions of the remaining glass during replacement of the broken glass on January 16th.

On January 16, Architectural Glass and Aluminum (AGA) removed the remaining glass pieces and installed a replacement spandrel glass (glass was taken from replacement spares kept in the building's mechanical penthouse). MCA was on site during the removal phase to investigate edge conditions not previously checked due to the glass remaining in place. The glass edges were verified not to be in contact with any metal framing pieces. The setting blocks were observed to be properly positioned. The back side of the brass bar was reviewed and no wear or burnish marks were observed indicating that something had been wedged between the brass bar and window. The glass break pattern that terminated to a focal point was photographed in place (Photo 9) and removed for further review and testing.

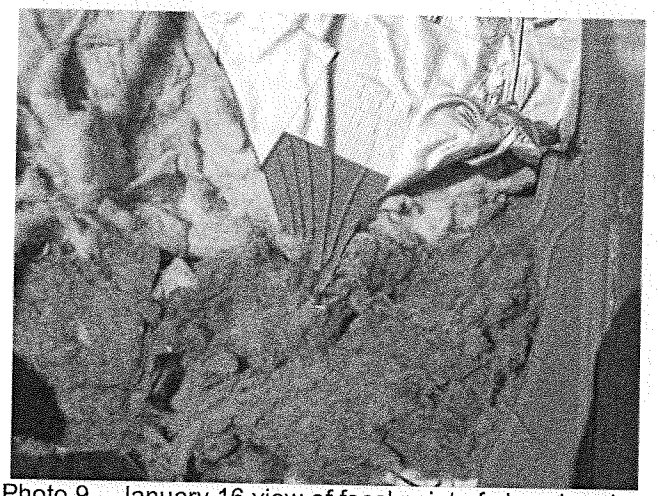

Photo 9 – January 16 view of focal point of glass break with the horizontal brass bar removed.

The glass closest to the focal point was forwarded to Mr. Schwartz for analysis and subsequent final report (attached 001TASchwartz-L-060230.00meh.pdf).

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Findings:

As stated in Mr. Schwartz's report, a definitive cause of the failure cannot be determined, but that with the information known a nickel-sulfide (NiS) fracture is the most likely cause.

Discussion:

There are no existing feasible procedures for determining this condition for glass that is already installed on buildings. The statistical proportion of NiS failures is slightly less than 2% of the total number of the heat strengthened windows (the spandrel glass) and the failure rate significantly falls off after 12 years but failures can occur up to 20 years after manufacture (attached AIS -13 A, Review of Nickel Sulphide Induced Fracture in Tempered Glass).

Recommendations:

The possibility of a future spontaneous fracture, though very limited, cannot be 100% ruled out. Consideration of applying a safety film (attached data sheet SH-4 CLARXL.pdf) to keep possible future glass breaks from falling or replacement with glass not considered to contain this element are the only options for greater assurance against falling glass. MCA did contact a contractor regarding applying a safety film and was given a budget of $100,000 per elevation ($400,000 for the building) to perform the work. MCA recommends additional contractors be contacted to firm up this budget, but believes the number provided to be, on order of magnitude, correct.

Please call me if you have any questions regarding the above information.

Regards,

Jeffrey Martin, P.E.
Principal
McGinnis Chen Associates, Inc.

Attachments: 001TASchwartz-L-060230.00meh.pdf
27 March letter.pdf
AIS-13 A, Review of Nickel Sulphide Induced Fracture in Tempered Glass.pdf
SH-4 CLARXL.pdf

Copy to: Jeff Chen (McGinnis Chen Associates, Inc.)

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Exhibit 7 – Vision Glass Letter Report dated May 31, 2012, from David Green, AIA, of Wiss, Janney, Elstner Associates, Inc.

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

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Via Email: tom.butt@intres.com

May 31, 2012

Mr. Tom Butt, FAIA
Interactive Resources
117 Park Place
Point Richmond, California 94801

Re: 450 N Street, Sacramento, California
Vision Glass Scratches
WJE No. 2012.0947

Dear Mr. Butt:

This report documents the investigation and findings of Wiss, Janney, Elstner Associates, Inc. (WJE) with respect to the scratched vision glass at 450 N Street in Sacramento, California.

Background

The 450 N Street building is a 24-story office tower constructed in 1991, housing the State Board of Equalization. The State of California Department of General Services (DGS) manages the building.

The primary exterior wall system on the building is a stick-framed aluminum curtain wall system with insulating (double-pane) vision glass, and monolithic (single-pane) spandrel glass. The vision glass consists of a tinted, heat-strengthened outer lite with a low-e coating on the No. 2 surface, a 1/2 inch airspace, and a clear, annealed inner lite.

Recently, six vision glass units at the north end of the 18th floor were reported to have cracked inner lites. Another consultant, McGinniss Chen Associates, reportedly investigated the lites in question and confirmed them to be cracked, prompting DGS to initiate replacement of the lites.

WJE was asked to confirm the nature and potential cause(s) of the distress and to make recommendations for further investigation or action by DGS.

Nomenclature

Locations of the six inner lites (hereinafter termed Lites #1 through #6) are indicated in Figure 1.

Reference is made in this report to the four surfaces of the two lites of glass in an insulating glass unit (IGU). These surfaces are numbered 1 through 4, from exterior to interior, per industry convention (Figure 2).

Directions indicated (left, right) are as viewed from the interior.

On-Site Evaluation

WJE visited the building on May 18, 2012, to review the reportedly cracked lites, to document the lites as they were removed for replacement, and to meet with building staff. We made the following observations:

Lite #1, North Elevation: WJE observed this lite being removed. On this lite we observed a group of three scratches originating at the left edge of the glass, approximately 8 1/2 inches from the bottom left corner. The scratches measured approximately 1 inch, 2 1/2 inches, and 9 inches in length (Figures 3 and 4). A fourth, perpendicular scratch intersects the upper scratch of this group, approximately 2 inches in from the edge. On the right side of the glass, we observed a 1 inch long scratch originating at the edge of the lite, approximately 11 1/2 inches from the bottom right corner with several 1/4 inch long scratches above and below it (Figure 5). The scratches were all on surface no. 4, the innermost surface, and coincided with location of glass edge damage. The outer lite was observed to have seamed edges (arrised corners), while the inner lite was observed to be an as-cut edge with damage at numerous locations along its perimeter, including chips and clamshells (Figure 6).

Lite #2, North Elevation: WJE observed this lite being removed (Figure 7). On the right side of the glass, we observed a 1 inch long scratch on surface no. 4, originating at the edge of the lite, approximately 11 1/2 inches from the bottom right corner. The scratch coincided with a location of edge damage. (Figures 8 and 9)

Lite #3, North Elevation: On the right side of the glass, we observed a scratch approximately 5 1/2 inches long on surface no. 4, originating at the edge of the lite, approximately 14 inches from the bottom right corner (Figures 10 and 11). The scratch continued behind the glazing gasket, beyond the normally exposed surface.

Lite #4, North Elevation: On this lite, WJE observed a jagged, s-shaped scratch approximately 9 inches inches long on surface no. 4, located approximately 5 inches from the left edge and 6 inches from the bottom of the lite (Figure 12). This scratch did not meet a glass edge. In the central region of the scratch, some glass appeared to have been spalled off (i.e., the scratch edges were somewhat jagged).

Lite #5, West Elevation: On this lite, WJE observed a 1 1/4 inch long scratch on surface no. 4, originating at the bottom edge, approximately 3 1/2 inches from the lower left corner (Figures 13 and 14).

Lite #6, West Elevation: On this lite, WJE observed a scratch on surface no. 3 (inside the cavity of the insulating unit), indicating it has been there since the time of its fabrication. The scratch is approximately 2 inches long and cuts across the bottom left corner of the lite. (Figures 13 and 15)

The lites all had a date stamp of “91-2” indicating that they were fabricated in February of 1991. This confirms that these lites are original to the building, and have been in service for 21 years.

Discussion and Recommendations

The scratches observed on the lites in question were all on the surface of the glass, and were not cracks through the body of the glass. All the lites except Lite #4 have scratches which continue beyond the edge of the normally exposed area of the lite, indicating that the scratches occurred during or prior to installation. At the lites that were removed, the scratches correlate with areas of edge damage. It appears that the scratches and edge damage (chips) were caused by the same event during shipping, handling, or installation. These lites with scratches have been in service for 21 years, without any incidents of

breakage of the inner lites of the vision glass units. We are not aware of any reports of broken inner lites of vision glass in the history of the building.

We offer the following comments regarding the influence of the observed scratches on the likelihood of future breakage:

Thermal Stress Breakage. The presence of flaws, particularly edge flaws, makes glass more susceptible to thermal stress breakage. However, systemic thermal stress breakage problems typically manifest themselves within 2 to 3 years of installation, as the building experiences a range of temperature conditions. Having now undergone more than 20 years of thermal cycling, it is likely that future temperature conditions will be no more adverse than those already experienced, making future thermal stress breakage unlikely at this point.

Wind Load Breakage. Any given lite of glass on the building may not yet have experienced its full design wind load during its life thus far. However, we have calculated the design wind load on the glass per the current California Building Code, and have determined by calculation per ASTM E1300[1] that the heat-strengthened outer lite alone is sufficient to withstand the design wind load. Even if one of the inner lites were to break, the risk of a subsequent breakage of the outer lite is low. Furthermore, visible flaws, such as the documented scratches, do not necessarily limit the ability of the glass to resist wind loads, especially if these flaws occur outside of the high stress regions of the glass (which is the case for Lite #1 through #3 and Lite #5).

Finally, with either breakage scenario, the lites in question are the inner lite of the IGU and they are made of annealed glass. Therefore, in the unlikely event they were to break, they would not pose a safety threat to passers-by below and the crack pattern would be such that the glass fragments would likely stay in the opening.

Based on the successful service history and minimal risks going forward, in general we do not believe there is a compelling justification for the removal and replacement of these six lites. If additional lites with surface or edge damage are brought to DGS's attention, WJE is available to review them to determine if a similar prognosis is appropriate.

Please do not hesitate to contact us if you have any questions.

Sincerely,

WISS, JANNEY, ELSTNER ASSOCIATES, INC.

David Green, AIA
Senior Associate

[1] ASTM E1300 "Standard Practice for Determining Load Resistance of Glass in Buildings" is the structural design standard for window glass referenced in the California Building Code.

Figures

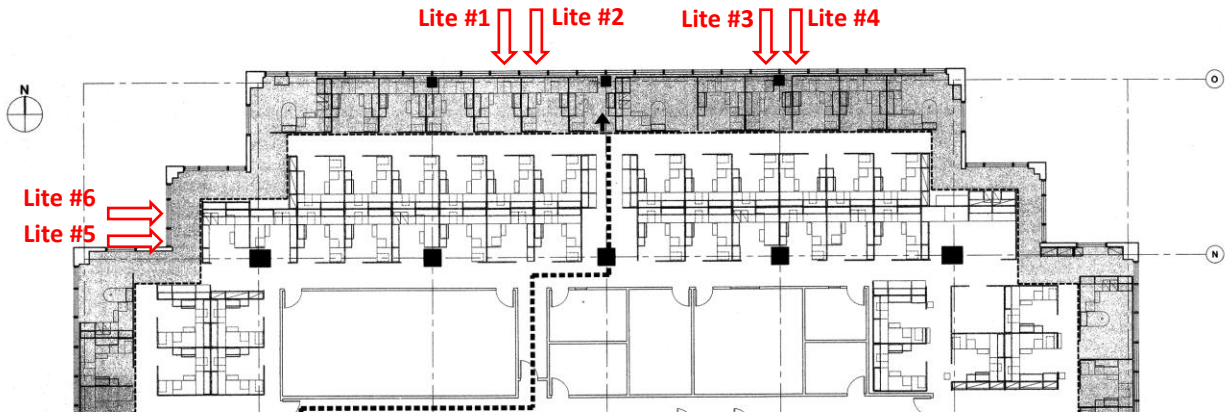

Figure 1. Partial plan of 18th floor indicating locations of reportedly cracked lites.

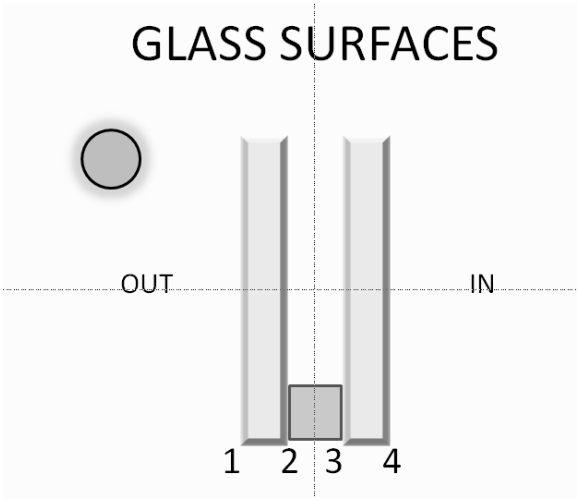

Figure 2. Glass surface nomenclature for double-pane insulating glass unit.

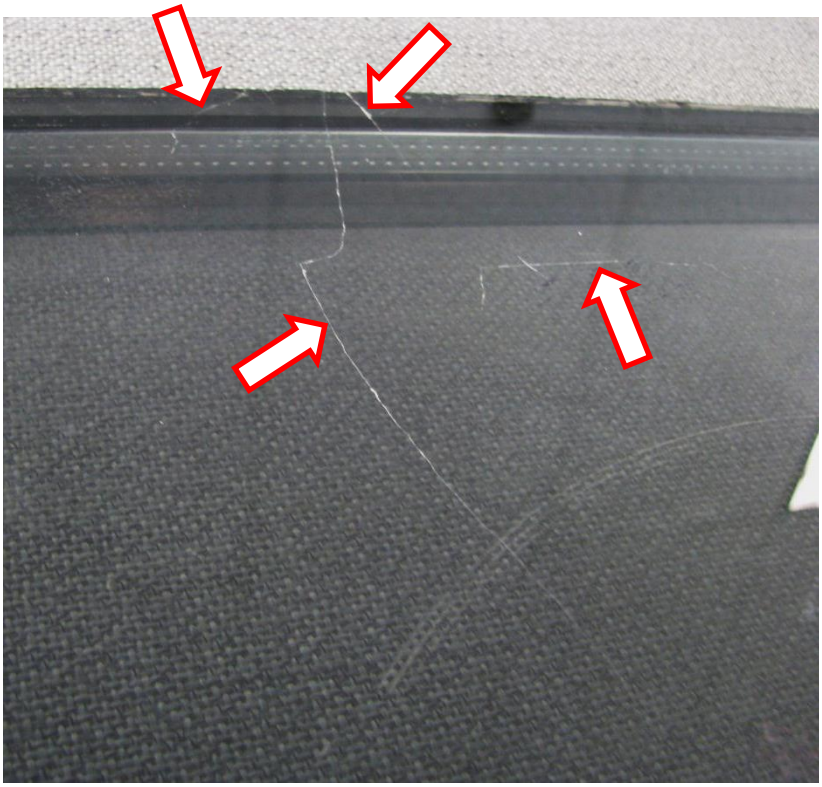

Figure 3. Scratches on left edge of Lite #1. Photo taken after lite was removed from window opening.

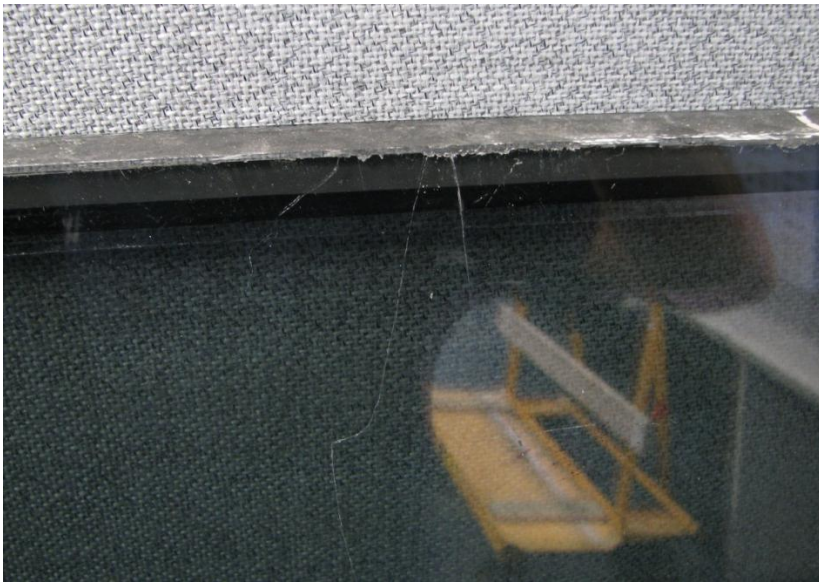

Figure 4. Scratches and edge damage on left edge of Lite #1 (same location as Figure 3). Photo taken after lite was removed from window opening.

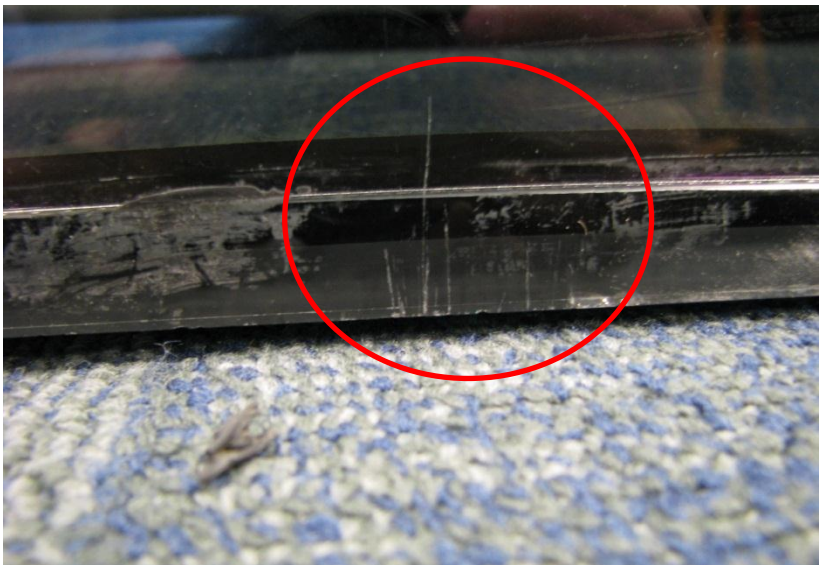

Figure 5. Scratches at right edge of Lite #1. Photo taken after lite was removed from opening.

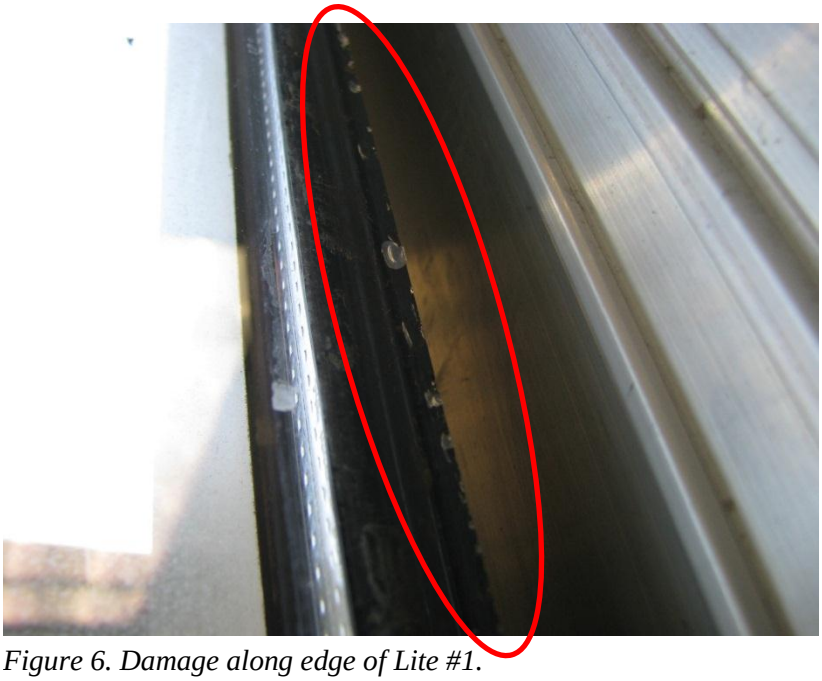

Figure 6. Damage along edge of Lite #1.

Figure 7. Removal of Lite #2.

Figure 8. Scratch on Lite #2.

Figure 9. Scratch and edge damage on Lite #2. Same location as shown Figure 8.

Figure 10. Scratch on Lite #3.

Figure 11. Scratch on Lite #3. Same location as Figure 10.

Figure 12. Scratch on Lite #4.

Figure 13. Lites #5 and #6 marked for removal.

Figure 14. Scratch on Lite #5.

Figure 15. Scratch on Lite #6, occurring on inner lite, surface no. 3. "Tempglass Eastern" stamp is on outer lite.

Exhibit 8 – Spandrel Glass Letter report dated May 31, 2012, from David Green, AIA, of Wiss, Janney, Elstner Associates, Inc.

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

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Via Email: tom.butt@intres.com

May 31, 2012

Mr. Tom Butt
Interactive Resources
117 Park Place
Point Richmond, California 94801

Re: 450 N Street, Sacramento, California
Spandrel Glass Breakage
WJE No. 2012.0947

Dear Mr. Butt:

This report documents the investigation and findings of Wiss, Janney, Elstner Associates, Inc. (WJE) with respect to spandrel glass breakage at 450 N Street in Sacramento, California.

Background

The 450 N Street building is a 24-story office tower constructed in 1991, housing the State Board of Equalization. The State of California Department of General Services (DGS) manages the building.

The primary exterior wall system on the building is a stick-framed aluminum curtain wall system with insulating (double-pane) vision glass, and monolithic (single-pane) spandrel glass with a ceramic frit on its back surface to provide opacification. An overall view of the building is shown in Figure 1.

The building reportedly experienced seven spandrel glass breaks between 1999 and 2005. A repair project in 2006 included mitigation measures to prevent spandrel breakage, and no further breaks occurred until January of this year, when a spandrel lite on the 9th floor, east elevation, reportedly broke spontaneously, prompting renewed concern. Some fragments of the lite fell to the ground while others stayed in the opening. The lite had already been replaced at the time we were contacted.

WJE was asked to investigate the potential cause(s) of the recent glass breakage and to make recommendations for further investigation or for action by DGS to mitigate the risk of similar breakage in the future.

Document Review

WJE reviewed the following documents made available to us:

- Report by McGinnis Chen Associates (MCA) titled "450 N Street Emergency Survey Investigation Report," dated November 15, 2005.
- Repair project drawings titled "450 N Street Curtainwall and Balcony Remediation," dated April 19, 2006, authored by MCA.
- Repair project glazing specification Section 08800, dated March 16, 2006, authored by MCA.

- Letter-report by McGinnis Chen Associates, titled "January 11, 2012 Glass Breakage Report," dated January 31, 2012.
- Letter-report by Simpson Gumpertz & Heger (SGH), titled "Spandrel Glass Stress Measurement, 450 N Street, Sacramento, CA," dated January 30, 2012.

Significant findings from our document review include the following:

Breakage History. The seven past spandrel breaks occurred between 2001 and 2005, and were located on the east, west, and south elevations between floors 7 and 10. One of the breaks, occurring in September 2005, was documented by MCA as having a fracture pattern characteristic of thermal stress breakage.

Surface Stress. Measurements of residual compressive surface stress (RCSS) in spandrel glass samples, taken in 2006 by SGH, averaged 9,492 psi. The RCSS in a fragment of the recently broken glass was reported by MCA to be 7,500 psi.

2006 Repair Program. In 2006 a repair program was implemented on the curtain wall system. In addition to various waterproofing repairs, it is our understanding that all spandrel lites were removed from their frames, inspected, and re-glazed. Those with questionable edge defects were replaced with new lites. It is not clear from the documents (nor have we been able to determine from speaking with building personnel) the quantity or location of replaced lites.

Suspected Cause of Recent Break. SGH and MCA were not able to definitively determine the cause of the recent break, although they consider spontaneous breakage from deleterious nickel sulfide (NiS) contamination to be the most likely reason.

On-Site Evaluation

WJE visited the building on May 8, 2012, to observe in-service conditions related to the spandrel glazing, to review fragments of the recently broken lite, and to meet with building staff. We made the following observations:

Glazing Conditions. The lite which was recently replaced at the 9th floor, east elevation was temporarily removed during our visit so that we could observe the glazing conditions, as was the lite immediately to its right. We made the following observations:

- The glazing pockets were clear of obstructions, gaskets were continuous and properly seated, setting blocks were properly located and we did not observe any conditions which might impart undue mechanical stress to the glass.
- We confirmed that a roughly 8 1/2 inch section of the inner glazing gasket is unsupported near the curtain wall slab-anchors because the aluminum gasket support profile is interrupted to allow for anchor installation (Figure 2). We believe it is unlikely, however, that this interruption causes a significant increase in mechanical stress in the glass.
- Glass bite and edge clearance appeared to be adequate to prevent contact of glass with the framing.
- Insulation at the lower half of the lite (below the floor slab) was found to be held off the glass by dimpled foam "egg-crate" material. The fire-safing and insulation above it, on the other hand, were found to be generally in contact with the back of the spandrel glass. (Figure 3)

- All lites (vision and spandrel) were observed to be "wet-sealed" with a fillet bead of sealant to the mullions at the exterior (Figure 4). This seal, installed during the 2006 repair project, would prevent the glass from "walking" in the glazing cavity over time and contacting the frame.
- A decorative horizontal brass bar spans across each spandrel opening, approximately at the floor slab/fire-safing level (Figure 4).
- The vertical mullions of the curtain wall framing are spliced within the spandrel openings every two floors. Pre-formed silicone boots were installed over these splices as part of the 2006 repairs (Figure 4). The recently broken lite occurred at a spandrel opening that did not contain a mullion splice.

Surface Stress Measurements. WJE took measurements using a grazing angle surface polarimeter (GASP) to determine the RCSS in the spandrel glass (Figure 5). We measured RCSS on fragments of the removed broken lite stored in the maintenance room, and also took in-situ measurements on the lites still on the building immediately to the left and right of the replacement lite. We found that the RCSS on the fragments of the broken lite averaged 7599 psi. Measurements on the lites to the left and right averaged 9226 psi and 8377 psi respectively.

Glass Breakage Fragments. Three large fragments of the recently broken lite that were stored in the building's maintenance room were made available for our review (Figure 6). The fragments discussed in the MCA and SGH reports were retained by those firms and were not available for our review. The three available fragments yielded little relevant information. We made the following observations:

- We did not find evidence of the fracture origin on any of the three fragments.
- The crack surfaces featured a line of roughness at the center of the glass, which is indicative of heat-strengthened glass (Figure 7).
- We did not find any fabricator markings on the glass. It could not be determined whether the broken lite was one which was replaced in 2006 or if it was original to the building.

Discussion and Recommendations

Time of Breakage

The time of breakage and the time of glass fall-out are not necessarily the same. The January 31 MCA report states that the glass "was reported to have broken and fallen to the ground at approximately 10:30 am (PST) on January 11, 2012." The report further states that "No staining was observed on the exterior glass surfaces indicating long-term glass breakage." Based on the documents we reviewed, we cannot be certain that the initial break occurred at that same time. It may have occurred days or even weeks earlier and propagated slowly prior to the glass falling out on January 11th. In our opinion, the lack of "staining" does not preclude the possibility that the glass initially cracked some time prior to 10:30 am on January 11th.

Possible Causes of Breakage

We did not find any evidence related to a fracture origin on the three fragments observed on site. The photos contained in the MCA and SGH reports indicate a series of fracture lines converging at a point approximately 8 to12 inches from the right edge of the lite, behind or just below the brass feature bar occurring at the floor line. The fragments making up the above fracture pattern were not available for our review. It is possible that they point to the origin of fracture.

Mechanical damage. Our review of the glazing perimeter conditions did not reveal any protrusions or anomalies in the glazing pocket. Furthermore, the wet-seal on the exterior perimeter of each lite keeps the glass from "walking" in the opening. Damage due to contact with the framing is therefore unlikely. Damage due to projectile impact, although unlikely given the apparent location of the fracture origin behind the brass bar, remains a possibility. Considering the distance above grade, only ammunition of some type would likely impact the subject spandrel glass with sufficient force to cause breakage.

Thermal stress. As reported by MCA and SGH, and confirmed by our limited measurements on site, the RCSS of the spandrel glass is typically either at the high end of the current standard range for heat strengthened (HS) glass or in between the high end of the range for HS glass and the low end of the range for fully tempered (FT) glass[1]. We found that the RCSS on the fragments of the broken lite averaged 7599 psi, which is consistent with the findings of SGH in their analysis of a fragment from the same lite. Our measurements of RCSS on the two lites adjacent to the one that recently broke were also consistent with SGH's reported 2006 findings of a measured RCSS range from 7,509 psi to 10,970 psi. HS glass is generally strong enough to resist thermal stresses in building conditions, and being at or above the high end of the HS RCSS range, the glass on this building should be even more resistant. Though damaged glass edges can significantly reduce the thermal resistance of the lite, the 2006 repair program, including glass replacement and wet-sealing to prevent glass from walking, should have practically eliminated the possibility of edge damage. For conventional dry glazed systems, thermal stress related glass failures typically originate at the weaker glass edges. However, the combination of a unique shading pattern from the brass bar and the intimate contact of the fire-safing and insulation on the backside of the glass above the brass bar may have created an unusually high thermal stress remote from the glass edge (closer to the apparent failure origin). In addition, thermal stress related failures generally manifest themselves within approximately the first two years after installation of the glass. Given all these factors, the probability of thermal stress breakage is low.

NiS Inclusion. NiS inclusions typically do not lead to spontaneous breakage in HS glass with an RCSS complying with the current ASTM standard. However, in our experience, NiS contaminated glass within the RCSS range measured by SGH (i.e., RCSS values above the current allowable values in ASTM) may be susceptible to spontaneous breakage. Typically, NiS inclusions, when they occur, are present in an entire batch of glass. It is possible that the broken lites, which occurred from floors 7 to 10, all originate from the same batch. Nonetheless, given the breakage history on the building, and the fact that NiS breakage on building exteriors typically begins during the first few years after installation and tapers off thereafter, the probability of NiS-induced breakage is low.

Wind Load. We researched local wind conditions reported by the National Oceanic and Atmospheric Association (NOAA) for date of the recent breakage and six prior weeks and found no significant wind events. We concur with the conclusion in the SGH letter that it is unlikely that glass breakage occurred as a result of wind load.

To summarize the above, none of the possible causes of the recent break are very likely, but at the same time, none can be definitively precluded.

[1] ASTM Standard C1048 "Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass" requires a RCSS between 3,500 and 7,500 psi for HS glass and a minimum RCSS of 10,000 psi for FT glass. Prior to 1997, the Standard allowed a maximum RCSS of 10,000 psi for HS glass.

Mitigation Measures

MCA makes two recommendations to DGS in their January 31 letter-report. We offer the following comments on these recommendations, for consideration by DGS:

Apply a safety film. MCA recommends that DGS consider applying a safety film as a mitigation measure against glass fallout due to possible future breakage. We would urge caution with regard to the application of film to the exterior of the glass. Warranties on external film application, if obtainable at all, will be of limited duration, and the film will likely not last more than 5 to 10 years before starting to deteriorate or delaminate. External film installation would result in an additional maintenance burden on DGS to periodically replace deteriorating film.

Application of safety film to the interior of the spandrel lites would offer greater durability, but would be a more costly and potentially disruptive undertaking. This work could be done from the interior, but would require the removal and replacement of the interior construction around the perimeter of every floor. Alternatively, the work could be done from the exterior, but would require the de-glazing of each lite, application of film to its back-side, and re-glazing it (including replacement of the wet-seal).

Replace the spandrel glass. MCA also recommends that DGS consider replacing the spandrel glass with new glass. In our experience, any wholesale glass replacement program is likely to yield some amount of glass breakage due to various random conditions (flaws in the glass, edge damage during installation, or other unforeseen possibilities). Given the very low rate of breakage of the existing glass (one lite in the six years since the 2006 remediation project), it is our opinion that the rate of future breakage will likely be the same if not higher with new glass than it would be with the existing glass is left in place. If replacement is contemplated, and DGS desires to minimize the risk from future breakage, we suggest that DGS consider replacing the glass with laminated glass or lites with a safety film pre-applied to the back-side of the glass, to provide post-breakage retention.

The cost and potential for disruption of building operations would need to be carefully considered with either approach.

Risk Considerations

Considering the limited number of breaks overall, and the long duration between this recent break and the previous occurrences, at this time there does not appear to be a systemic breakage problem. Given the age of the original and replacement glass, the time period during which thermal stress or NiS-related failures might typically be anticipated has passed. While there can be no guarantee that future breakage will not occur, in our opinion, the risk of future breakage is more or less the same as the breakage risk in any other high-rise building of similar age with heat strengthened spandrel glass. Consequently, no extensive mitigation measures are necessary if ownership accepts the risks common to similar heat strengthened spandrel glass in similar vintage high-rise curtain walls.

If the above-described risk is acceptable to DGS, as an additional precaution, they might consider monitoring the spandrel glass for a period of time. A monitoring program might consist of a binocular survey on a regular schedule of decreasing frequency.

The only way to preclude future spandrel glass fallout is to replace the glass with laminated or safety-filmed lites or to apply a safety film to the existing lites. As stated above, with any replacement scenario,

some breakage will likely occur, but with lamination or film application, fallout risk would be virtually eliminated.

The opinions expressed in this report are based on the evaluation of available information and limited field observation and testing. WJE reserves the right to modify our opinions if supplemental information becomes available for our review.

Please do not hesitate to contact us if you have any questions.

Sincerely,

WISS, JANNEY, ELSTNER ASSOCIATES, INC.

David Green, AIA
Senior Associate

Figures

Figure 1. Overall view of building.

Figure 2. Gasket support profile interrupted at anchor location.

Figure 3. Spandrel area with glass removed. Fire-safing at floor level and insulation above it are generally in contact with back of glass. Insulation below safing is held back from the glass by the use of dark-colored foam egg-crate material. Some of the insulation below the floor line has been temporarily removed in this photo.

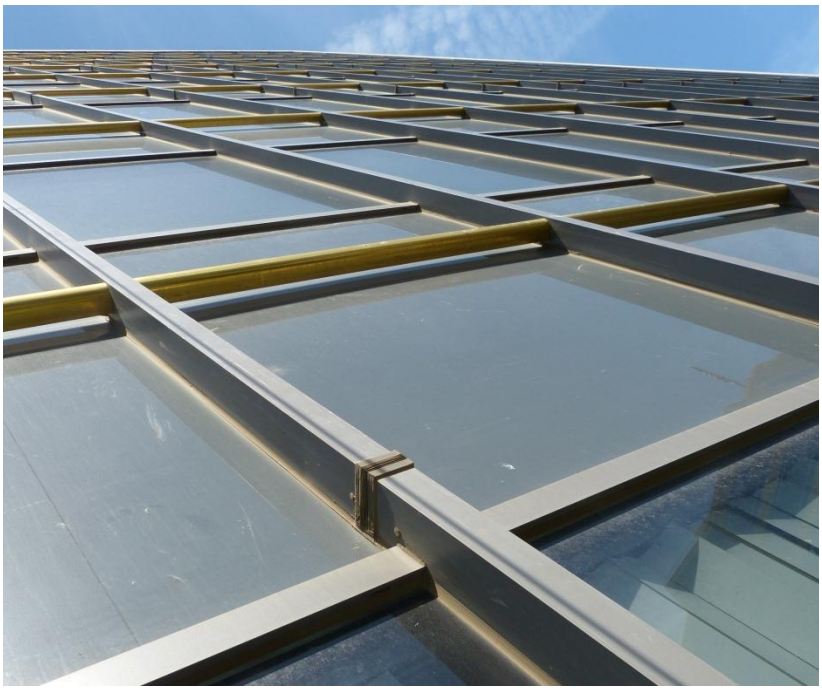

Figure 4. View looking up at curtain wall showing wet-seal around glass perimeter and pre-formed silicone boot over mullion splice, both from the 2006 repair project. Also visible is the brass bar suspended in front of each spandrel lite.

Figure 5. GASP device in use to measure RCSS of spandrel lites.

Figure 6. Three sections of the broken spandrel lite made available for our review.

Figure 7. Line of roughness in center of glass thickness, typical of heat-strengthened glass.

Exhibit 9 – Author and Peer Reviewer Curriculum Vitae

INTERACTIVE RESOURCES
Architects & Engineers

THOMAS K. BUTT, FAIA, LEED AP BD+C

PRESIDENT
PRINCIPAL-IN-CHARGE
ARCHITECTURE DIVISION
ARCHITECT, LEED® AP

EDUCATION

- Master of Architecture, Urban Design, University of California, Los Angeles, 1973
- Bachelor of Architecture and Bachelor of Arts, University of Arkansas, 1968
- Engineer Officer Basic Course, U.S. Army Corps of Engineers, Ft. Belvoir, Virginia, 1968

CERTIFICATION

- Licensed Architect (California, Arkansas, and Nevada)
- Certification, National Council of Architectural Registration Boards
- Licensed General Contractor, California #290922
- LEED Accredited Professional

PROFESSIONAL EXPERIENCE

- Interactive Resources, 1973-present
- Mayhew and Thiederman, Architects, Inc., San Francisco, 1970-71
- Edward Durell Stone, Inc., Palo Alto, 1967-70
- U.S. Army Corps of Engineers (military service), 1968-70
- Department of the Interior, National Park Service, 1963-66

PROFESSIONAL ORGANIZATIONS

- American Institute of Architects, Elected to the College of Fellows, 1995
- Construction Specifications Institute (CSI)
- National Trust for Historic Preservation
- Western Construction Consultants Association (WESTCON), Charter Member
- American Society for Testing and Materials (ASTM), Committee E-6, Performance of Buildings, C-11, Gypsum and F-06, Floor Coverings
- International Code Council (ICC)
- Roof Consultants Institute (RCI)
- American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. (ASHRAE)
- Congress for the New Urbanism

OTHER ORGANIZATIONS

- Arkansas Alumni Association, life member and past president, Bay Area Chapter

HONORS AND AWARDS

- Arkansas Alumni Association 2005 National Community Service Award
- Arkansas State Senate Citation for a "distinguished career filled with notable accomplishments."
- Arkansas Traveler
- ASTM Award of Appreciation for Outstanding Service
- Hall of Honor, Fayetteville Public Education Foundation
- East Bay Chapter of the American Institute of Architects Practice and Technology Achievement Award for "determination to explore issues of building technology and his efforts devoted toward sharing his findings with the public and the profession."
- West Contra Costa Unified Education Fund Distinguished Citizen Award
- Coast Guard Meritorious Public Service Award
- President of the United States Award for Outstanding Community Achievement of Vietnam Era Veterans
- National Trust for Historic Preservation Honor Award
- Grand Award (Interactive Resources, Inc) for Design Excellence, National Association of Industrial and Office Parks
- Department of Transportation Award (East Brother Light Station, Inc.) for Outstanding Public Service to Transportation and Historic Preservation

DIAGNOSTIC ARCHITECTURE AND CONSTRUCTION TECHNOLOGY

- More than 350 consulting assignments relating to construction failure or construction litigation, including 10,000 units of housing.
- Expert witness in over 100 construction litigation cases, including trial testimony in California and Oregon courts
- Serves on three committees and chairs two ASTM task groups related to moisture problems in buildings
- Arbitrated dozens of construction disputes through the auspices of the American Arbitration Association, served on its panel of arbitrator trainers, and as a faculty member in continuing education of arbitrators.

REPRESENTATIVE NEW AND REHABILITATION BUILDING DESIGN

- Limoneira Solar Project (LEED Gold), Santa Paula, CA
- Emerson School Solar Project, Berkeley, CA
- 801-851 Traeger Façade Restoration, San Bruno, CA

INTERACTIVE RESOURCES
Architects & Engineers

- Oak Grove Apartments Construction Defect Repairs, Healdsburg, CA
- BART Leak Investigations - Powell Street, Pleasant Hill and Richmond Stations
- The Landing at Jack London Square, Construction Defect Repairs, Oakland, CA
- Mariner Square and Baltic Square, Richmond, CA
- College of San Mateo Building 18 Rehabilitation, San Mateo, CA
- Margaret Lesher Student Union Building, Diablo Valley College

HISTORIC PRESERVATION

- National Trust for Historic Preservation volunteer in New Orleans Katrina Damage Assessment Team, 2005
- Completed more than 100 projects involving restoration or rehabilitation of historic structures, many of which are listed on the National Register of Historic Places.
- Lectured widely on historic preservation practice to groups including the National Trust for Historic Preservation Annual Convention, the Monterey Design Conference, and many civic clubs and organizations.
- Prepared and administered numerous successful grant applications for historic preservation projects and National Register Nominations and Certifications.

ENERGY CONSERVATION AND ALTERNATIVE ENERGY APPLICATIONS

- Early work in alternative energy and energy conservation set the pace in California in the years immediately following the energy crisis of 1973, influencing subsequent state energy conservation legislation and speeding the incorporation of energy conservation considerations into the mainstream of California architectural practice.
- Completed more than 100 projects between 1973 and 1983 that incorporated cutting-edge active and passive solar, wind, and other energy conservation technology. Those included private homes, apartments and condominiums, commercial and public buildings, and swimming pools. Many have been published in local, regional, and national media.
- In 1975, organized and implemented the first statewide California Solar Energy for Buildings Conference, repeated in 1976 and 1977 with hundreds of building industry professionals attending.
- Secured six U.S. Government-sponsored grants for research or demonstration projects in solar energy.

CURRENT PUBLIC SERVICE

- City of Richmond City Council, Elected Member and Vice-Mayor, Richmond City Council, 16 years. Served as vice-mayor twice and chair of Public Safety/Public Services Committee, Rules and Procedures committee, Personnel Committee and Finance Committee
- BCDC Commissioner (Alternate to Tom Bates, Mayor of Berkeley)
- Contra Costa LAFCO Commissioner (Alternate to Contra Costa Conference of Mayors representatives)
- Best Local Politician, *East Bay Express*, May 2004
- Board of Directors, Local Government Commission, Chair 2008-10
- Board Member, Rosie the Riveter Trust, President 1999-2011
- Board Member, President, East Brother Light Station, Inc.

PAST PUBLIC SERVICE

- City of Richmond representative, West Contra Costa Transportation Advisory Committee (WCCTAC)
- Commissioner for Qualifications Appraisal Interviews, California State Board of Architectural Examiners
- Chair, West County Agency
- District Chairman, Herms District, Diablo-Silverado Council, Boy Scouts of America
- Board of Directors, Richmond, California, Chamber of Commerce
- Chairman, Richmond Economic Development Commission
- President, Washington School PTA
- President, Point Richmond Business Association
- President, Point Richmond Neighborhood Council
- Board of Arbitrators, American Arbitration Association
- Citizen's Advisory Committee for Richmond, California Shoreline Conservation and Development Plan, the Knox Freeway-Cutting Boulevard Corridor Study, and the North Richmond Shoreline Specific
- Richmond CETA Advisory Committee
- Richmond Community Development Commission
- Richmond Rotary Club, past President

PUBLICATIONS

- Vinyl Windows May Exacerbate Water Intrusion in Stucco Walls
- Thomas K. Butt, "Water Resistance and Vapor Permeance of Weather Resistive Barriers," *Journal of ASTM International*, Vol 2, #10 (West Conshohocken, PA: Nov/Dec 2005)
- Local Government Takes Aim at Invasive Exotic Plants," *Noxious Times*, March 1999
- "Concrete Floor Flatness & Levelness Tolerances," *The Construction Specifier*, November 1994
- "Moisture Problems in Slabs on Grade: An Update," *The*

Construction Specifier, December 1993
- "Thin Brick Veneer," *The Construction Specifier*, August 1993
- "The Condo Conundrum," *The Construction Specifier*, May 1993
- "Be Prepared for Building Failures and Disasters," *Black's Office Leasing Guide*, Winter 1993
- "Avoiding and Repairing Moisture Problems in Slabs on Grade," *The Construction Specifier*, December 1992
- "Common Interest Development Maintenance Manual," *ECHO: Executive Council of Home Owners*, May 1991
- "Building Failure: Limiting the Losses," *Best's Review,* September 1990
- "Thin Brick Veneer: A Guide to Trouble-Free Application," *Sun Coast*, December 1989
- "How CADD Helped Restorations-Documentation and Design For A California Town," *Architecture Magazine*, November 1989
- "Do You Need A Building Detective?," *Facility Manager*, Winter 1988-89
- "Condominium Maintenance Manual," *Community Associations Institute Newsletter,* Vol. 8/No. 2, June/July 1988
- "Arbitrator Discusses Complex Problems of Condo Ownership," *Contra Costa Times*, November 4, 1984
- "Construction Defects in Residential Condominiums," *Courier* (Newsletter of the Council of Condominium Homeowner Associations, Inc.), Vol. 2, Nov./Dec. 1984
- *California Sunshine, A Consumer Guide to Solar Energy*, California Energy Resources and Development Commission (Thomas K. Butt, Project Director), 1977
- *Guidelines for Evaluating New Development in Contra Costa County, CA*, 1976
- *The Working Woodburner, Home Heating and Cooking with Fireplaces and Wood Stoves*, Dennis Dahlin, Author & Thomas K. Butt, Project Manager, 1976
- "Solar Energy Homes, New Market For Realtors," *California Real Estate*, October 1975

REPRESENTATIVE SPEAKING ENGAGEMENTS
- Sheet Metal Flashings, RCI Symposium, Downey, CA, 2011
- Sheet Metal Flashings, WESTCON Symposium, Albany, CA, 2010
- Stucco as a Weather Protection System," a Westcon/RCI seminar, San Diego, 2010
- "Green Buildings and Energy Efficiency," Green is Gold Expo, Richmond, 2009
- "Plaza and Deck Waterproofing," a Westcon/RCI seminar, Long Beach, 2008
- "Stucco as a Weather Protection System," a Westcon/RCI seminar, 2007
- "Water Intrusion – An Age Old Challenge to Architects," Water Intrusion – A Beutler Educational Forum
- Roofing Consultant's Institute, Southern California, ASTM E2266 Symposium on Design and Construction of Low-Rise Frame Building Wall Systems to Resist Water Intrusion
- " The Enduring Mystery of Weather Resistive Barriers and the Need for Standards," Westcon ASTM E2266 Symposium on Design and Construction of Low-Rise Frame Building Wall Systems to Resist Water Intrusion,
- "Water Resistance and Vapor Permeance of Weather Resistive Barriers," ASTM Symposium on Performance and Durability of Window-Wall Interface, 2004
- "Specifications and the Need for Standards," BETEC 2004 Symposium on Enclosure Wall Systems
- "Weather Resistive Barriers and Flexible Flashings," Western Region AAMA Meeting, 2004
- "What Elected Officials, Architects, Planners and Local Officials are Doing," Local Government Commission 3rd Annual New partners for Smart Growth Conference, 2004
- "The Design Professional's Standard of Care - Using Reasonable Diligence and Best Judgment," Westcon 2000 Symposium and May, 2001 Meeting
- "Something Fishy is in the Neighborhood," Local Government Commission Building Livable Communities Conference 2000
- "Moisture Problems in Concrete Slabs on Grade," World of Concrete, 1998
- "Forensic and Diagnostic Architecture," AIA Redwood Empire Chapter, 1997
- Moderator and speaker at "Putting Our Communities Back On Their Feet" conference by Local Government Commission, 1996
- "Moisture Problems in Concrete Slabs on Grade," Construction Consultants Association of Northern California, 1996
- "Jobsite Problems, Solutions and Perceptions: Why are the Architect and Contractor Treated So Differently?," The Northern California Construction Institute, 1993
- "Building Failures and Subsidence," California Building Industry Association, Sacramento, CA, 1991
- "Forming and Running a Practice," East Bay Chapter, AIA, Practice Management Seminar Series, 1989, 1990
- Training and Evaluation Seminar, The American Arbitration

Association, Continuing Education for Arbitrators, 1989
- Light House Preservation Workshop, National Trust for Historic Preservation, Annual Convention, 1989
- "Polymer Modifier and Grouts and Mortar," Ceramic Tile
- Institute, Dallas, TX, 1989

MILITARY SERVICE

U.S. Army Corps of Engineers, 1968-1970

Rank at Discharge: 1st Lieutenant
Vietnam Service: 1969-1970
Decorations:
The Bronze Star, Army Commendation Medal, Republic of Vietnam Campaign Medal and Vietnam Service Medal

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

Mark K. Schmidt

Unit Manager and Principal

EDUCATION

Valparaiso University
Bachelor of Science, Civil Engineering, 1983
University of Wisconsin, Madison
Master of Science, Structural Engineering, 1987

REGISTRATION

Professional Engineer in Florida
Structural Engineer in Illinois

PRACTICE AREAS

Facade Assessment
Glass Performance Studies
Historic Preservation
Litigation Support
Prepurchase Surveys
Repair and Rehabilitation Design

EXPERIENCE

Since 1982, Mr. Schmidt has worked in several WJE offices: Denver, Dallas, and the Northbrook headquarters. During this time, he has focused on the assessment, preservation, remedial design, and implementation of restoration programs for a variety of building envelopes. He has led investigations involving glass and aluminum curtain walls, architectural precast concrete panels, thin stone veneers, stone and brick masonry, terra cotta, door and window assemblies, skylights, composite panels, mosaic tile systems, and EIFS and stucco systems.

Mr. Schmidt has performed hundreds of building envelope investigations addressing operational concerns (such as water infiltration and corrosion), safety concerns (such as glass breakage, anchorage and component failure), and aesthetic concerns (such as finish or surface degradation). He has developed a specific area of expertise related to the assessment of architectural glass components.

Mr. Schmidt has also participated in a wide variety of investigations, structural analyses, and repair design projects involving concrete, steel, aluminum, masonry, and wood structures.

REPRESENTATIVE PROJECTS

Facade Assessment

- John Hancock Building: Evaluation of corroded curtain wall components, Chicago, Illinois
- Transamerica Center: Repair alternatives for mosaic tile and glass facade, Los Angeles, California
- National Institute of Health: investigation of aluminum sunshade failure, Bethesda, Maryland

Glass Performance Studies

- Numerous investigations involving glass breakage resulting from inclusions, thermal stresses, improper glazing techniques, and natural disasters
- Various evaluations of glass surface distress resulting from construction activities, cleaning processes, and natural disasters
- Various studies of glass product failures

Historic Preservation

- 135 South LaSalle Street: Limestone, brick, and sealant repairs to landmark building, Chicago, Illinois
- Miami-Dade County Courthouse: Investigation of distressed historic terra cotta facade, Miami, Florida

Litigation Support

- Salt Lake City Airport: Mediation regarding exterior metal curtain wall panels, Salt Lake City, Utah
- Sherwood Hotel: Arbitration regarding Typhoon Paka damage to EIFS facade, Tamuning, Guam
- Various litigations regarding glass damage or breakage

Prepurchase Surveys

- High-rise architectural/structural prepurchase assessments in various U.S. cities

Repair and Rehabilitation Design

- Schaumburg Corporate Center: Waterproofing repairs to glass and aluminum curtain wall systems, Schaumburg, Illinois
- One Brickell Square: Restoration of white precast concrete facade, window systems, trellis systems, and parking garage, Miami, Florida
- Court House Center: Structural, waterproofing, and precast concrete facade repairs, Miami, Florida
- James R. Thompson Center: Waterproofing repairs and snow melting system for 165-foot diameter skylight, Chicago, Illinois
- Highland Place One: Waterproofing repairs to glass and lock-strip gasket curtain wall, Englewood, Colorado

PROFESSIONAL AFFILIATIONS

American Society of Civil Engineers (ASCE)
ASTM International (ASTM)

TECHNICAL COMMITTEES

ASTM C14 - Glass and Glass Products
ASTM C24 - Building Seals and Sealants

A. WILLIAM LINGNELL
CONSULTANT
LINGNELL CONSULTING SERVICES
1270 Shores Court
Rockwall, Texas 75087
(972) 771-1600

B.S. (Civil Engineering), Ohio University, 1965
M.S. (Civil Engineering), University of Toledo, 1967
M.S. (Mechanical Engineering), University of Toledo, 1970
M.S. (Engineering Science), University of Toledo, 1974

Bill Lingnell has been involved in engineering, technical management and construction of major building projects throughout the United States, Canada, and other countries. He has consulted as a technical authority and specialist for general contractors, manufacturers, fabricators, owners, developers, architects, and individuals relating to the many facets of glass and wall systems used on architectural construction projects. As a consultant, he has also served engineers, testing agencies, insurance companies, building managers, window producers, curtain wall consultants and the legal profession on many projects and assignments requiring specialization in glass and wall system technology. He serves as the technical consultant to the Insulating Glass Manufacturers Alliance (formerly Sealed Insulating Glass Manufacturers Association–SIGMA). Lingnell has over 46 years of experience in the technical field of glass and architectural products and is considered one of the world's foremost experts in the field.

Prior to becoming a consultant, Lingnell held senior management level positions at the following companies: Indal Wall Systems as Vice President of Engineering and Technical Services, Olden and Company as Corporate Vice President and Libbey Owens Ford Company as Director of New Products and Technical Services. In each company he had responsibilities for strategic business planning and technical development of new business opportunities. Other responsibilities included development, research, engineering, and manufacturing direction for a variety of architectural glass and wall products as well as quality assurance and quality improvement programs.

Lingnell has completed all course work requirements for a doctorate in engineering mechanics and has held the position of Adjunct Professor in the Engineering College at the University of Toledo. He is a Registered Professional Engineer (by examination) in Arizona, Ohio, North Carolina, Pennsylvania, and Texas. As a member of various professional groups, code bodies, trade organizations and industry associations, he has contributed in the writing of standards pertaining to the use and testing of glass, wall systems, sealants and wall components through ASTM committees E-6 and C-24.

PROFESSIONAL CHRONOLOGY: Structural Engineer, Senior Engineer, Manager Technical Services, Director Technical Services and New Products-LOF Company (1965-84); Vice President – Olden & Co. (1984-90); Vice President – Indal Wall Systems (1990); President – *LINGNELL CONSULTING SERVICES* (1990 -).

MEMBERSHIPS: American Architectural Manufacturers Association, American Association for Wind Engineering, American College of Forensic Engineers, American Society of Civil Engineers, American Society of Heating Refrigerating and Air-Conditioning Engineers, American Society for Testing and Materials, American Welding Society, Association of Construction Inspectors, Construction Specifications Institute, Glass Association of North America, National Fenestration Rating Council, National Fire Protection Association, National Glass Association, National Society of Professional Engineers, International Building Code.

LINGNELL CONSULTING SERVICES

(Partial list of services)

- **Glass selection and design guidance**
- **Drawing review of wall and glass applications for new construction**
- **Problem assessment of glass failures in existing buildings**
- **Diagnostic analysis of wall system conditions in existing buildings**
- **Due diligence studies of building walls**
- **Pre-construction estimating for budgeting**
- **Study of manufacturing/fabrication operations**
- **Quality improvement programs and follow-up monitoring**
- **Engineering review of calculations for wall applications**
- **Specification preparation for glass and wall systems**
- **Systems consulting**
- **Technical marketing services**
- **New product development**
- **Forensic engineering for glass/wall system analysis**
- **Engineering studies and fracture mechanics review of glass breakage**
- **Fractographic analysis of glass**

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lingnell@swbell.net

LINGNELL CONSULTING SERVICES
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1270 Shores Court
Rockwall, Texas 75087
(972) 771-1600

January 2, 2011

FEE AND BILLING STRUCTURE FOR A. WILLIAM LINGNELL

General Fees:	**$180.00/Hour for "Office work"** **$1,800.00/Day for "Out-of-town" work**
Reimbursable Expenses:	**All travel and living expenses plus normal "out-of-pocket" expenses associated with work product**
Billing Period:	**Monthly invoices will be sent to client with supporting receipts and professional fees**

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

David Green

Senior Associate

EDUCATION

University of California, Berkeley
Bachelor of Arts, Architecture, 1994
Columbia University
Master of Architecture, 1998

REGISTRATION

Architect in Hawaii
National Council of Architectural Registration Boards Certificate

PRACTICE AREAS

Curtain Wall Systems
Exterior Wall Systems
Glass Performance
Roofing and Waterproofing
Construction Documents and Specifications
Peer Review
Repair and Rehabilitation Design

EXPERIENCE

Mr. Green is an architect and building envelope consultant specializing in curtain wall, glazing, and cladding systems. He has designed, detailed, investigated, and overseen the construction of building envelope systems for various building types, including high-rise hotels and condominiums, museums, retail storefronts, universities, and office buildings.

Prior to joining WJE, Mr. Green was a senior associate at Handel Architects, where he served as both a project manager and an in-house cladding consultant. Prior to that, Mr. Green was an exterior wall consultant with R.A. Heintges & Associates in New York City, where he gained valuable experience working with a variety of complex building enclosure systems.

REPRESENTATIVE PROJECTS

Curtain Wall Systems

- 1100 Broadway, Oakland, California: Curtain wall consultant for twenty-story office tower with complex geometry
- Gannett/USA Today Headquarters, McLean, Virginia: Curtain wall consultant for large corporate headquarters*
- PNC Place, Washington, D.C.: Curtain wall consultant to Gensler for LEED Platinum office building

Exterior Wall Systems

- Millennium Tower, San Francisco, California : Project architect and in-house cladding consultant for fifty-eight-story residential tower*
- Museum of Modern Art, New York, New York: Curtain wall consultant for expansion and renovation by architects Yoshio Taniguchi and KPF*

Glass Performance

- Library Building, Boston, Massachusetts: Evaluation of anisotropy in tempered insulating glass
- Office Building, Boston, Massachusetts: Investigation of corrosion of low-e glass coating
- UC Santa Cruz McHenry Library, Santa Cruz, California: Investigation of glass breakage and framing distress
- Parking Garage, San Francisco, California: Investigation of repeated breakage of decorative glass cladding.

Roofing and Waterproofing

- 1515 Third Street, San Francisco, California: Consultant for six-story office building
- San Jose Airport, San Jose, California: Peer reviewer and consultant for new terminal building and additions to existing terminal

** Indicates with previous firms*

PROFESSIONAL AFFILIATIONS

American Institute of Architects (AIA)
American Society for Testing and Materials (ASTM)
Architectural Engineering Institute (AEI)

TECHNICAL COMMITTEES

AEI Curtain Wall Committee
ASTM E06.51- Performance of Windows, Doors, Skylights, and Curtain Walls

Exhibit 10 – Peer Review

LINGNELL CONSULTING SERVICES
A. WILLIAM LINGNELL, P. E.
1270 Shores Court
Rockwall, Texas 75087
(972) 771-1600
lingnell@swbell.net

Re: Tempered or Heat-Strengthened Glass Breakage
Protocol for Obtaining Breakage Particles

The follow steps should be followed when obtaining the broken particles of tempered or heat-strengthened glass from the exterior of the building for further investigation as to the probable cause(s) of breakage:

1. **Locate the initial break area. This is usually identified by a portion of the glass that appears like the center of a spider web. This is illustrated in the photo below.**

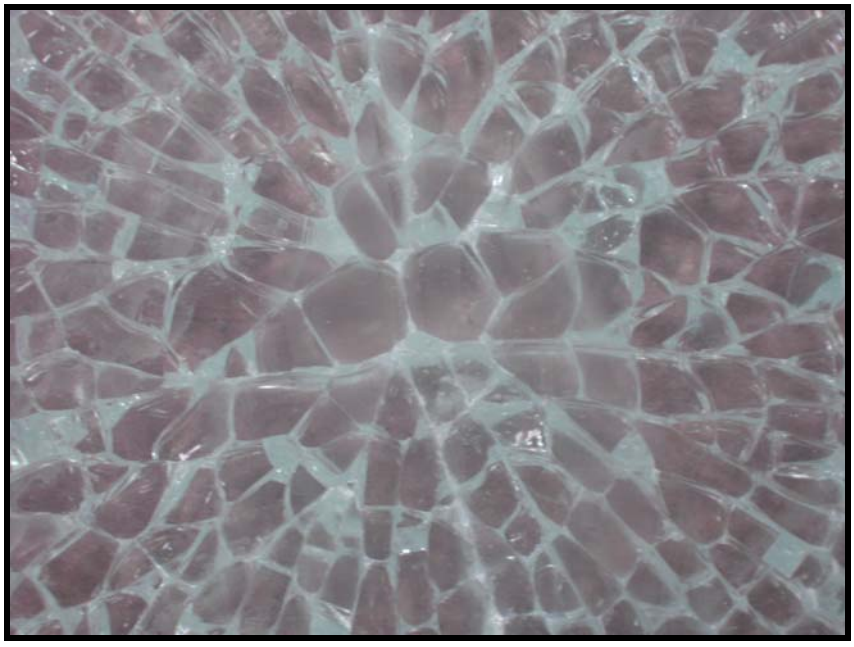
2. **Once the actual initial break (fracture origin) area is identified photos and documentation of the site conditions and glass should be recorded. The data sheet attached can be used as a guide to record pertinent information.**

3. **Glass should be observed to make certain that glass fallout is not occurring or has the potential to occur that will be a public safety issue.**

4. **Proper precautions shall be made to secure the relevant particles required for a laboratory examination.**

5. **Using a transportation lift or scaffolding to reach the area of the identified fracture origin careful inspection around the area must be taken to retrieve the pieces required.**

6. **Carefully use clear packing tape (2" wide or greater) or a clear film to obtain an area of 5" x 5" or more for preservation. This section can be marked with a "Sharpie" permanent marker so that it can be retrieved if necessary or if glass becomes dislodged during the removal process. The photo below is an example of the area retrieved:**



7. **A suitable means of removing the glass safely should be adopted using plywood or other suitable material to contain the glass and fracture origin and place the glass on a flat or horizontal surface to remove the required sample that is taped together.**

8. **The sample with the identified fracture origin taped up can then be packaged using sufficient packing materials to avoid further fracturing and then forwarded to the following address for laboratory examination and fractographic analysis:**

LINGNELL CONSULTING SERVICES
A. WILLIAM LINGNELL, P. E.
1270 Shores Court
Rockwall, Texas 75087
(972) 771-1600

LINGNELL CONSULTING SERVICES
A. WILLIAM LINGNELL, P. E.
1270 Shores Court
Rockwall, Texas 75087
(972) 771-1600
lingnell@swbell.net

LABORATORY EVALUATION OF TEMPERED GLASS

PROJECT NAME: _____
PROJECT ADDRESS: _____

GLASS MANUFACTURER: _____
GLASS FABRICATOR: _____

SIZE : **LENGTH** ___ **in**
WIDTH ___ **in**
THICKNESS ___ **in**

GLASS TYPE:

SUBSTRATE _____
COATING TYPE _____
EDGE TREATMENT _____
GLAZING SYSTEM _____
FRACTURE ORIGIN_LOCATION _____

INVESTIGATION OF GLASS:

DATE OF GLASS BREAKAGE _____
LOCATION ON BUILDING _____
WEATHER CONDITIONS _____
NOTABLE OBSERVATIONS _____
_____
_____

PHOTOS OF GLASS: **SKETCH OF BREAKAGE:**

Include with data and information

LINGNELL CONSULTING SERVICES
A. WILLIAM LINGNELL, P.E.
1270 Shores Court
Rockwall, Texas 75087
(972) 771-1600 Tel * (972) 771-0354 Fax
lingnell@swbell.net

Board of Equalization Building
450 N Street
Sacramento, CA 95814

Glass Breakage Review

Prepared for :

Mr. Thomas K. Butt, FAIA
Principal
Interactive Resources
Architects & Engineers
117 Park Place
Point Richard, CA 94801

Prepared by:

LINGNELL CONSULTING SERVICES
Rockwall, Texas
June 14, 2012

LINGNELL CONSULTING SERVICES
A. WILLIAM LINGNELL, P.E.
1270 Shores Court
Rockwall, Texas 75087
(972) 771-1600 Tel * (972) 771-0354 Fax
lingnell@swbell.net

June 14, 2012

Mr. Thomas K. Butt, FAIA
Principal
Interactive Resources
117 Park Place
Point Richard, CA 94901

Re: Board of Equalization Building Project
450 N Street
Sacramento, CA 95814
Forensic Analysis – Glass Breakage
Review of Engineering Reports and Documents

Dear Mr. Butt:

Please refer to your request to have *Lingnell Consulting Services (LCS)* provide a peer review of the documentation, reports, and information provided relating to glass breakage on the above referenced subject. A recent transmittal dated June 6, 2012 contained the documents and exhibits being used to offer a report to the Department of General Services (DGS) Board of Equalization Building Project. The following documents and exhibits have been studied and reviewed:

1. Board of Equalization Building, 450 N Street, Sacramento, CA – Forensic Analysis – Glass Breakage, June 6, 2012 by Thomas K. Butt, FAIA.

2. Section 08800, Glass and Glazing, Capitol Square Specifications, November 5, 1991, Dreyfuss & Blackford Architects.

3. 450 N Street, Emergency Survey Investigation Report, McGinnis Chen Associates LLP, Architects Engineers, November 15, 2005.

4. Drawings, 450 N Street, Curtain Wall and Balcony Remediation, April 19, 2006, (JR Roberts As-Builts), McGinnis Chen Associates, Inc.

5. Specification Section 08800, Curtain Wall and Balcony Remediation, March 16, 2006, McGinnis Chen Architects, Inc.

6. Letter dated January 30, 2012 from Thomas A. Schwartz and Stephen S. Ruggiero of Simpson Gumpertz & Heger to Jeffrey Martin, AIA of McGinnis Chen Associates, Inc.

7. Letter dated January 31, 2012 from Jeffrey Martin, P. E. of McGinnis Chen Associates, Inc., to Joan Armstrong of DGS.

8. Vision Glass Letter Report dated May 31. 2012 from David Green, AIA of Wiss, Janney, Elstner Associates, Inc.

9. Spandrel Glass Letter dated May 31. 2012 from David Green, AIA of Wiss, Janney, Elstner Associates, Inc.

After review and study of the information provided, the following comments are offered:

The glass breakage concerns were reviewed by investigators from McGinnis Chen (MC), Simpson Gumpertz & Heger (SGH) and Wiss Janney Elstner (WJE). Based on the information presented by the referenced investigators the glass breakage evidence from glass particles and site inspections did not give conclusive irrefutable facts that would determine the exact cause of breakage of the various spandrel and vision glass experienced on this project.

There were possible causes suggested along with site inspections of the glass conditions and glazing system that would give one some probable reasons for glass breakage, however, a clear cause was not identified in the information provided. The "450 N Street Emergency Survey Investigation Report", item 3 above provides a comprehensive analysis of the project with regard to the glass and glazing system conditions and provides a segue to the remedial work that was subsequently performed on the project. While one break referenced in the report (Number 6 2005 September) was documented as "is the pane that showed classic thermal break pattern as documented by Jeff Martin of MCA" a fracture origin was not obtained to determine the actual cause of the fracture other that what was stated. Glass breakage due to a thermal break condition is usually manifested from one or more of many possible contributors, namely a few are poor edge work, flaws in the glass surface, damage on or near the edge, shadow conditions, impact damage, higher than normal temperatures, or internal devices or insulation causing high temperature differences within the glass. Tracing the fracture pattern back to the origin and a fractographic examination of the fracture lines, surfaces and edges will give important clues as to determining the probable cause of breakage. From the information presented it did not appear as though this opportunity was presented for the glass breakage that occurred in the project.

There were broken samples that were sent to SGH in 2006 for determination of the surface compression level on the heat-treated glass. The residual surface compression stresses (RSCS) were determined to be in the range of what is expected for heat-strengthened glass prior to the ASTM C 1048 standard being changed to a maximum of 7,500 psi with a minimum of 3,500 psi. Additional photos and glass samples were sent to SGH for examination with no fracture origins contained with the glass shards sent. SGH provided information on possible causes of the fracture

and stated that since there were not obvious external sources of stress it would "indicate that nickel sulfide impurities as the likely cause".

Following is a general discussion of breakage from nickel sulfide inclusions for background and information. In the manufacture of float glass, there is a possibility that certain impurities may be introduced during the glass melting in the molten glass process. Many of these impurities cause no particular problem and are not harmful to the end product unless they are of the nature that they are cosmetically not acceptable. Some impurities may remain in a solid, opaque state and appear as dirt, refractory stones or other inclusions within the glass. The number and spacing of inclusions and point blemishes allowed are specified in the ASTM C 1036 Standard, "Standard Specification for Flat Glass." With few exceptions, the inclusions are considered to be appearance imperfections only; and do not affect the performance of the glass in any way. Nickel sulfide inclusions are the exception to this rule when certain conditions apply when glass is heat-treated.

The inclusions represented by nickel sulfide are formed whenever any nickel-rich contaminate such as nichrome wire, stainless steel particles, welding rods, particles from wear plates, or other nickel containing contaminants are unintentionally introduced into the glass melting furnace along with the desired batching materials. The nickel may combine with sulfur in the furnace fuel or the batch materials to form nickel sulfide inclusions. In annealed glass, the glass manufacturing process for soda lime silica float glass commonly used throughout the world for architectural projects, these inclusions are harmless and are considered on the same basis of all other inclusions and point blemishes.

Glass manufacturing facilities can produce up to 500 to 800 tons of glass per day. Considering this large volume of glass, total elimination of contaminants is not always possible. Manufacturers take extraordinary steps to secure uncontaminated materials and run the materials through certain metal detector devices and other contamination location type facilities prior to entering the batch material in the melting furnace.

Annealed glass is commonly used as the product for heat-treating glass to enhance glass strength and load-carrying capabilities, and also produce a safety glass product when considering fully tempered glass. During the process of heat-treating glass, the nickel sulfide inclusions are transformed into a state such that irreversible expansion occurs with time and temperature. If the inclusion is tightly held in the glass and not surrounded by any bubble or area that will allow its expansion, the expansion over time may produce sufficient stress to cause spontaneous glass breakage.

The expansion of the inclusions is known to be very temperature dependent and also time weighted. Glass that has a high time weighted average temperature will experience breakage much sooner than glass that is generally cooler, all other items being equal. The period of time for the inclusion to reach its ultimate size varies and can range from up eight years or more for glass on the exterior of a building. At present, there is no practical method of inspecting the glass to determine which lites may have harmful nickel sulfide inclusions and which do not.

The fracture caused by the expansion of the inclusion is quickly propagated into the tempered glass because of the high tensile stress inherent in the center thickness portion of the glass. The level of these stresses is much lower in heat-strengthened glass. The possibility of breakage from heat-strengthened glass is lowered because of the lower tensile stress in the center of the glass and corresponding lower compression stress. Fortempered glass, the compression stress levels and center tension stress levels are much higher than heat-strengthened; therefore, the possibility of spontaneous fracture from nickel sulfide stones has generally shown to be higher in fully tempered glass. As stated tempered glass is known to have a much higher incidence of breakage due to the presence of harmful nickel sulfide inclusions, however, experience has demonstrated that heat-strengthened at the upper level of the allowable RSCS for the ASTM C 1048 standard can on occasion cause breakage.

It has been shown in studies that the use of a heat-soaking technique by which fully tempered or heat-strengthened glass after the fabrication of the glass and the heat-treating process has been completed are subjected to a time-temperature device which is intended to eliminate the majority of any harmful nickel sulfide stones that may exist in the glass. While this method has been shown to eliminate up to ninety percent or more of the nickel sulfide inclusions, it is not a guarantee that all nickel sulfide inclusions will be captured. The heat-soaking method is conducted by placing the glass in an oven at a high temperature for a predetermined time in order to cause the nickel sulfide inclusion to expand to the point of manifesting into a fracture and be eliminated from the glass order. This can be accomplished by many of the heat treat fabricators offering this as an extra operation for heat-treated glass.

The above referenced information is to offer an explanation of the nickel sulfide stone breakage characteristics that can occur in heat-treated glass. While this is a rare condition and a very low percentage of glass is found on buildings when this event occurs, it is imperative to keep complete records and obtain fracture origins whenever possible to ensure that the actual cause of breakage is identified. Other causes of glass fracture have been attributed to causes such as the following: glass surface damage from impact, vandalism, manufacturing and building services/occupants; glass edge damage from handling, framing system movement causing glass to metal contact or loss of edge support; excessive forces from the glass framing and structural support system; wind loads greater than the specified design; weld spatter from construction trades; thermal stress; wind blown debris; seismic stresses; and static fatigue overcoming the RSCS causing a constant tensile stress on the edge or surface.

The important evidence to obtain and retain for study after a glass lite has broken is the fracture origin. This portion of the broken glass is the area where the actual glass began to break and will give important clues as to the actual cause of breakage. Without having the break origin, it is impossible to identify the cause of breakage with any degree of reasonable scientific certainty. While the investigators on the project WC, SGH and WJE did an extensive study on the glass and glazing system available there is not clear evidence that fracture origins were obtained to give verifiable evidence toward confirmation as to the actual cause of breakage in any of the units examined or on record as reported broken. WJE examined interior

glass on units that were reported as fractured that turned out to be scratches not cracks thus not leading to a probable cause of breakage of lites were not actually broken.

Methods of mitigation were suggested for the spandrel glass to minimize the possibility of glass falling out of the area in the rare case of glass breakage by the investigators. The use of replacement with a laminated glass construction was referenced or consideration of a safety film applied to the existing glass. While each of these has merit it is a building management decision by DGS to go in that direction. In each case the glass would be contained and the probability of obtaining the fracture origin greatly enhanced. While laminated glass would eliminate the original glass in the spandrel area there would be certain building interruptions during the reglazing process. Exterior safety film has been successfully applied to glass and when breakage does occur the fracture origin has been secured. It is usually recommended that an edge attachment method or special sealant technique applied to insure that the glass will stay captured be incorporated into the design. It is highly recommended that a test program be instituted prior to the safety film application to verify that the method is sound and will meet the requirements of DGS.

A method or protocol system to obtain fracture origins should the event of future breakage occur was not found in the information provided. An attachment with this brief report is intended to give building management and operating personnel guidance to use in isolating the proper glass fragments to secure should breakage occur in the future. While this attachment is basic in the approach it is imperative that all glass particles be kept for future examination. The protocol is to be used in a manner that is safe to occupants and building personnel.

If you have any questions or desire any clarification of the materials presented feel free to contact me.

Sincerely,

A. William Lingnell

A. William Lingnell, P. E.
Engineering Consultant

Attachment: Protocol for Obtaining Breakage Particles