

INVESTIGATION OF THE SEPTEMBER 9, 2015 COLLAPSE OF AIRCRAFT HANGAR NO. 14 AT NEWARK LIBERTY INTERNATIONAL AIRPORT, NEWARK, NJ

U.S. Department of Labor
Occupational Safety and Health Administration
Directorate of Construction

February 2016



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NEWARK LIBERTY INTERNATIONAL
AIRPORT, NEWARK, NJ**

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Background

On September 9, 2015 at Newark Liberty International Airport, Newark, NJ, around 1:25 p.m. aircraft hangar no. 14, undergoing demolition, unexpectedly collapsed, injuring four employees. The demolition workers were on the first floor (ground floor) and the second floor of the hangar when the hangar building collapsed. Four employees were transported to the hospital with nonlife threatening injuries. One employee was kept overnight in the hospital for evaluation of his head injuries.

The Occupational Safety and Health Administration's (OSHA) Regional Administrator, Region II asked the Directorate of Construction (DOC), OSHA National Office in Washington, DC to provide engineering assistance to the Parsippany Area Office in its investigation for a causal determination. Two structural engineers from DOC arrived at the incident site after the collapse to inspect the incident site, observe the failure, obtain relevant documents pertaining to the incident and interview the witnesses. In addition, the documents prepared by a consultant outlining the demolition procedure were obtained from the job site. The following are the pertinent drawings.

Drawings: G101 to G106, ES001 to ES004, S101 & S102.

Original existing building drawings: 201 to 204.

Consultant's engineering report was also obtained from the job site.

The Project

Aircraft hangar No. 14 was built in 1956 and was owned by United Airlines at the time of construction. The building is a former aircraft hangar with a two-story office component. In later years, the hangar was owned by the Port Authority of New York and New Jersey (Port Authority) and was used for overnight aircraft parking. For the last decade, however, no airplanes were parked inside, and the building was largely used for storage. The Port Authority decided to demolish hangar No. 14, and nearby hangars No.s 95 and 332. The following were the participants in the demolition project.

Owner:	Port Authority of New York and New Jersey (Port Authority).
General Contractor:	VRH Construction Corporation (VRH) of Englewood, NJ.
Demolition Contractor:	CATCO Demolition Services (CATCO) of Montville, NJ.
(Subcontractor)	
Consulting Engineer for CATCO:	Bertin Engineering (Bertin) of Glen Rock, NJ.
Custodian of original design drawings:	Dewberry Engineers Inc. of NJ.

General demolition drawings prepared by: Dewberry Engineers Inc. of NJ.
Specific demolition procedure by: Bertin Engineering (Bertin) of Glen Rock, NJ

Contract drawings for the demolition of existing hangars no.s 14, 95 and 332 were prepared by Dewberry Engineers Inc. of NJ for the Port Authority. The Port Authority awarded the contract for demolishing existing hangars 14, 95 and 332 to the low bidder VRH. The contract included removal and disposal of the entire building components from roof to the piles cut off 1'-0" below the bottom of the pile cap. VRH retained CATCO as a subcontractor to demolish all three hangars. CATCO hired Bertin as an engineering consultant to prepare demolition procedure. Initially, VRH/CATCO/Bertin proposed to demolish hangars no.s 95 and 332 using conventional methods and submitted the manner of demolition to the Port Authority for approval. A subsequent submission was followed for conventional demolition of hangar no. 14. The Port Authority approved the conventional method for demolishing hangar no.s 95 and 332 but not for hangar no. 14. The Port Authority required controlled demolition and detailed procedure for hangar no. 14 as it was a two-story high building with a cantilever roof truss. The hangar (building) no. 14 was built on a pile foundation. The building was approximately 200' long and 300' wide (see Figures 1 to 3). The building was located on the north portion of the complex, north of the runways, and closer to the access ramps for the highways. The building was not in close proximity to a residential neighborhood or other public buildings. The first floor (ground floor) of the building consisted of 5" to 6" thick slab on grade. The second floor slab consisted of 5" thick post tensioned concrete slab, supported on structural steel beams spaced at 6'-8" on center. The second floor, 300' long and 40' wide, was used as an office building. The remaining area was open to the roof for the maintenance of the aircraft on the first floor (ground floor). The roof for the entire building consisted of a structural steel framing. The metal roof decking was supported over steel joists placed on approximately 8' deep steel trusses spanning in an east-west direction. The steel trusses were supported on grid line A and grid line C columns with an overhang of approximately 160' from columns at grid line C. Neither demolition drawings prepared by Dewberry for hangar no. 14 nor existing original drawings contained any information regarding structural steel member sizes for the roof, roof truss, floor heights, etc. Because the roof of hangar no. 14 was supported on a cantilever truss and was two-stories high, CATCO asked his consultant Bertin to develop an engineering (control) collapse method for the controlled collapse procedure (engineering collapse). The procedure was approved by the Port Authority/Dewberry Engineers, Inc. on June 16, 2015.

Controlled Collapse Procedure by Bertin

Bertin asked the Port Authority for the original construction drawings of hangar no. 14 to prepare the demolition procedure. The custody and recordkeeping of the original construction drawings

were given to Dewberry Engineers Inc. of NJ by the Port Authority. Bertin received the available drawings from Dewberry. Unfortunately, those drawings contained information related to reinforced concrete only and not to the structural steel framing. It is assumed that the Port Authority never received a complete set of the original construction drawings for hangar no. 14 from United Airlines. Bertin conducted an initial site visit on December 15, 2014 to observe the general conditions of the building. Bertin did not take any field measurements to determine the actual sizes of the steel members due to budgetary constraints. Bertin initially considered making assumptions about the sizes of the structural steel framing members including cantilever trusses, steel columns, and joists to perform calculations for the demolition. However, Bertin decided against making any assumptions as they would be unreliable. Based on Bertin's expertise in demolition procedures, Bertin issued a demolition sequencing report on January 8, 2015 to CATCO. The demolition report included the following industry standards and guidelines to be followed.

- Safety program prepared by the general contractor VRH.
- Procedures for operating, maintaining, and controlling forklifts, hydraulic excavators, steel loader, etc.
- Ladder safety, tool safety, lead safety and guidelines, etc.
- Demolition sketch (see Figure 4) prepared by Bertin.

The demolition report also included systematic removal of dead loads from the roof line of the structure to the floor at grade reversing the sequence used when the building was constructed. However, CATCO required that the steel superstructure and sway bracings remain in place during the removal of the dead loads. After all the dead loads have been removed, the steel superstructure would then be prepared for a controlled collapse. The consultant designated the original first and second floor (Figures 2 & 3) as the ground floor and first floor, respectively in his sketch SK-1 (Figure 4). In this report, the consultant's floor designations have been used. Bertin indicated the following cuts in the column flanges (see Figures 4 & 5).

- Two horizontal V cuts (one above and one below the height of the cable pull) in the flanges of the C line columns above the ground floor. Since no cut was made in the web, each cut would result in a hinge support for the column.
- One 45 degree cut in the flanges of the C line columns at the ground floor level.
- A 45 degree cut (at the height of the cable pull) on all perimeter column flanges located above the ground floor (see Figure 4).
- No cuts were indicated for the flanges above the first floor columns.

The first floor structural slab would remain intact to maintain stability and to provide a counterweight to the cantilever truss. After the cuts in the flanges were provided as indicated by Bertin, the contractor was to wrap the 1" diameter wire rope cable to pull four individual

columns located on grid line “C”. The pull would be toward the west, perpendicular to column line “C” and away from the runways, active roadways and taxiways. The force of the pull using excavators would cause the column webs along column line “C” to yield and bend, thereby making the entire superstructure and roof kneel in a measured fall with the roof trusses remaining generally intact and landing on the ground floor. Bertin stated that this procedure is arguably safer than cutting the trusses and picking them up from a higher elevation. Bertin’s control collapse procedure was approved by the Port Authority.

Collapse

The day before the collapse, CATCO removed all doors, windows, partition walls, and exterior non-load bearing walls. Upon completion of the interior “shell out”, CATCO turned the building over to VRH for the lead abatement process on the paint over the columns. After the paint abatement was completed by VRH, CATCO made horizontal V cuts (one above and one below the direction of cable pull) in the flanges of the following columns. All cuts were made using a torch. The following data were received from CATCO.

- The cuts were made at the following locations on columns located above the first floor (see Figure 6):
 - Columns located on grid line “C”, “B”, and on the perimeter columns located on grid line “A”, line “1”, and line “14”. Even though cuts at these locations were not mentioned by Bertin in his sketch (Figure 4), they were performed by CATCO. It appears that CATCO did not follow the documents provided by Bertin. In addition, the superintendent indicated in a meeting that he did not review Bertin’s demolition drawings prior to or after the cuts were made.
- The cuts were made at the following locations on columns located above the ground floor (see Figure 6):
 - Perimeter columns located on column line “A”.
 - Top cut only on column C-4.
 - Cut above and below the direction of the cable pull on column C-5, C-6, C-7, C-8, C-9, C-10, C-11, C-12, C-13, and C-14.
 - 20 cuts remained to be made.

In addition to the above cuts, a CATCO employee started to make a horizontal V cut at the bottom of column C-13 at the ground floor, and within a few seconds the roof along with the first floor collapsed on the ground floor (see Figures 7 to 29), trapping nine workers working beneath the roof and the first floor. It is noteworthy that the horizontal V cut performed by CATCO at ground level on column C-13 was in violation of the 45 degree cut recommended by Bertin (see Figures 4 & 5).

See attachment A for the sequence of events prepared by CATCO.

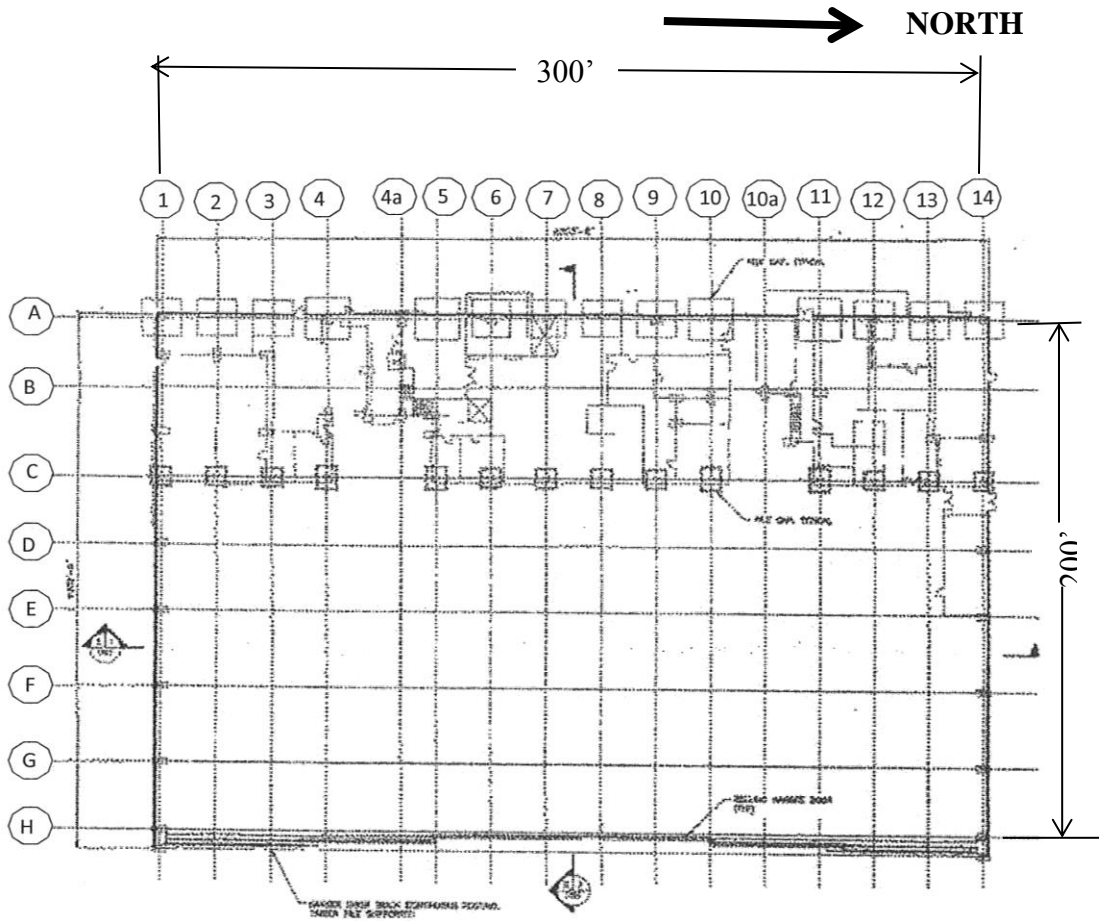
Engineering review

CATCO made top and bottom cuts on flanges of the columns at the ground level as well as at the first floor instead of only at the ground floor columns as specified by Bertin in his sketch (Figures 4 & 5) for the demolition report of May 20, 2015. The cuts on the flanges at the ground and first floor columns severely weakened the load carrying capacity of the columns by introducing “hinges” in columns at each cut in the flanges of the column (see Figure 6). In addition, CATCO made a horizontal V cut instead of a 45 degree cut at ground level on column C-13, which further weakened the column and initiated the collapse of the entire building. If CATCO had provided cuts as specified by Bertin in his sketch (see Figures 4 & 5) for the demolition report, the strength of the columns would not have weakened to cause the collapse. The horizontal V cuts and 45 degree cuts as shown on Bertin’s sketch would have softened the structure and brought down the roof and first floor at a lower level so that CATCO could demolish the remaining structure using mechanical equipment.

Conclusions

1. The demolition contractor failed to follow the instructions of May 20, 2015 prepared by his engineering consultant.
2. The contractor made numerous horizontal V cuts on columns above the first floor, contrary to the consultant’s instructions. These additional cuts in the columns compromised the stability of the structure and significantly contributed to the collapse.
3. The general contractor failed to notice and question the numerous cuts in columns made by the demolition contractor in violation of the instructions of the consultant retained by the demolition contractor. These cuts were in plain view of the general contractor.
4. The Port Authority of New York and New Jersey had an incomplete set of original drawings.

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Foundation Plan at Hanger No. 14
(NTS)

FIGURE 1 (reproduced from Bertn's Report)

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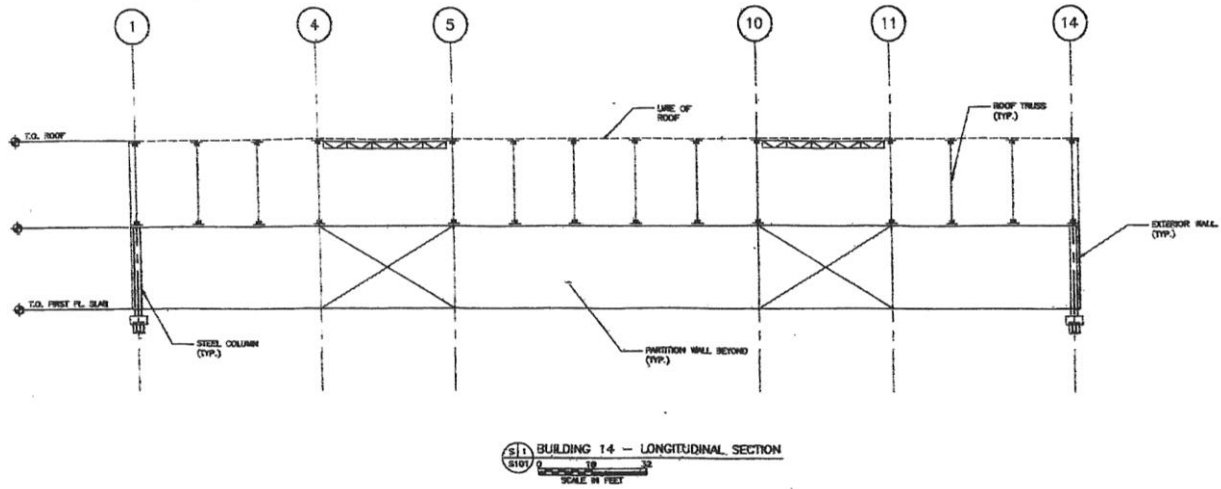


FIGURE 2 (Reproduced from Port Authority drawing no. S102)

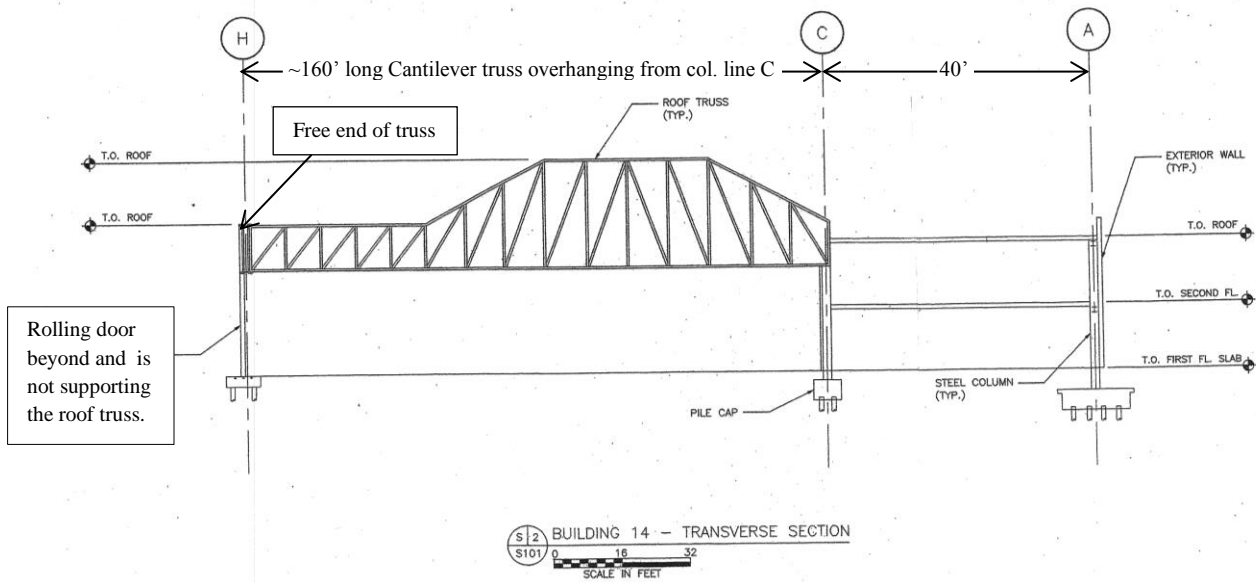
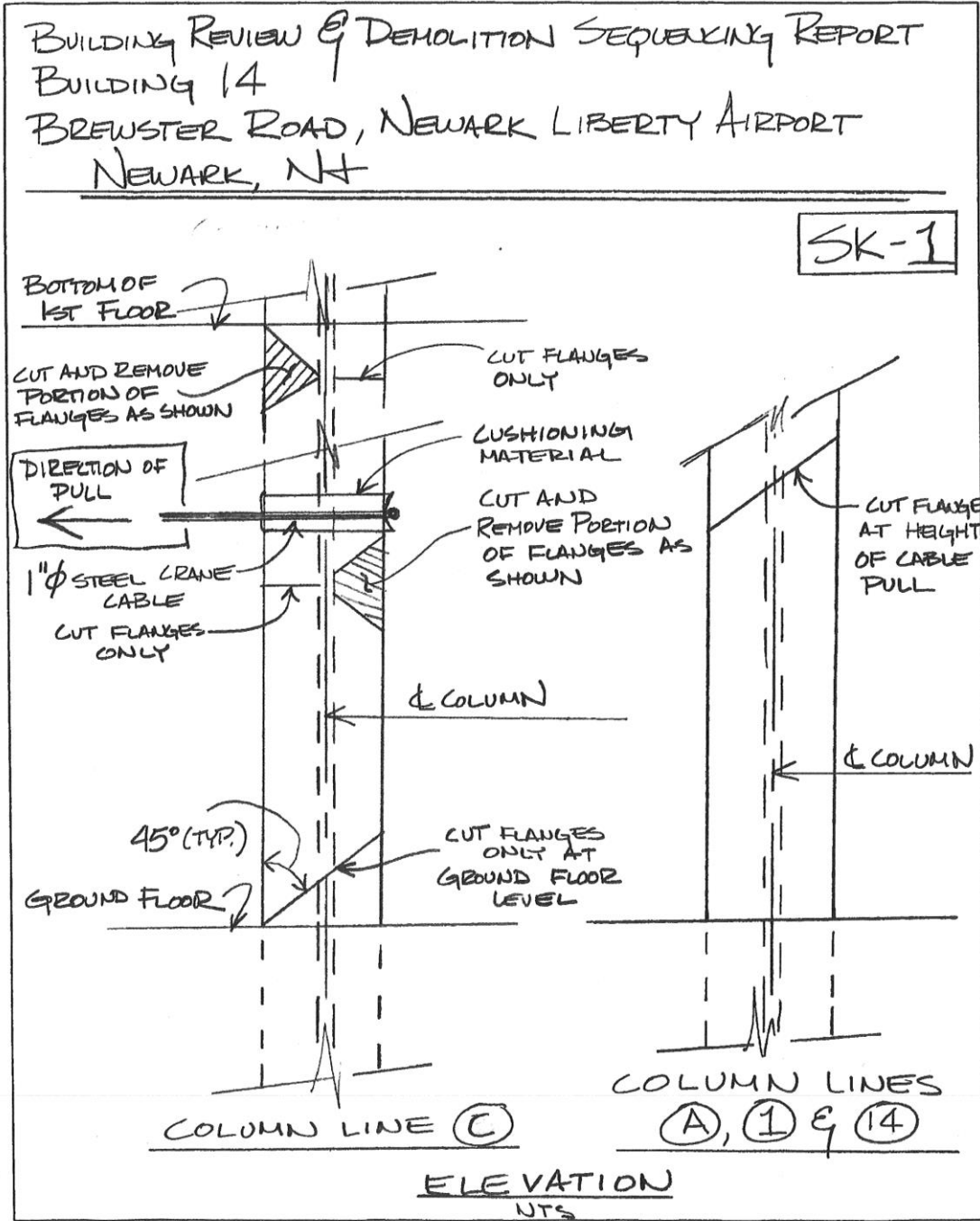


FIGURE 3 (Reproduced from Port Authority drawing no. S102)



JWB
 SHEET NO. 84 OF
 CALCULATED BY CBI DATE 5/20/15
 CHECKED BY DATE
 SCALE



BERTIN ENGINEERING • 66 GLEN AVENUE • GLEN ROCK, NJ 07452 • P 201.670.6688 F 201.670.9788 • www.bertinengineering.com

FIGURE 4 (reproduced from Bertin's Report)

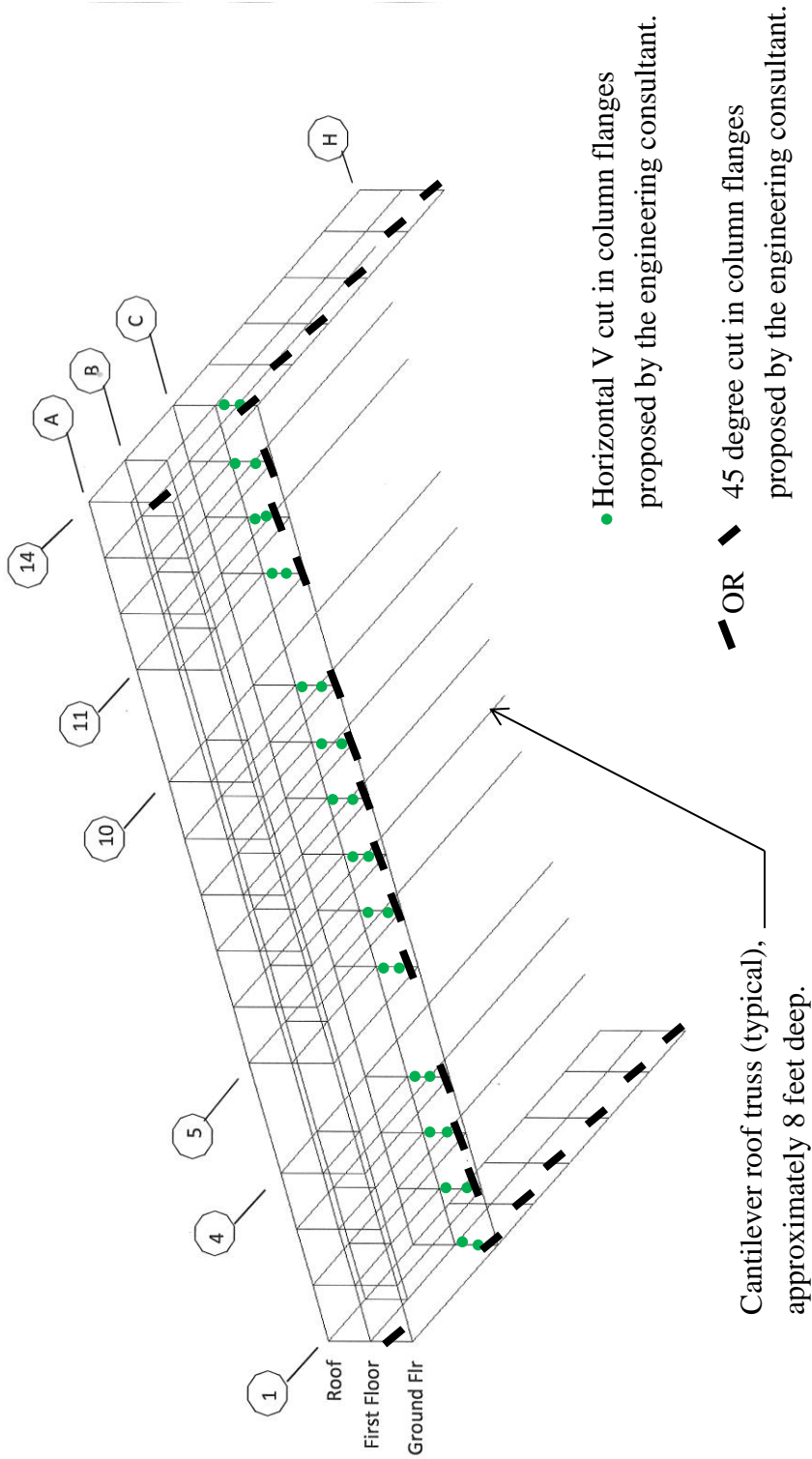


FIGURE 5

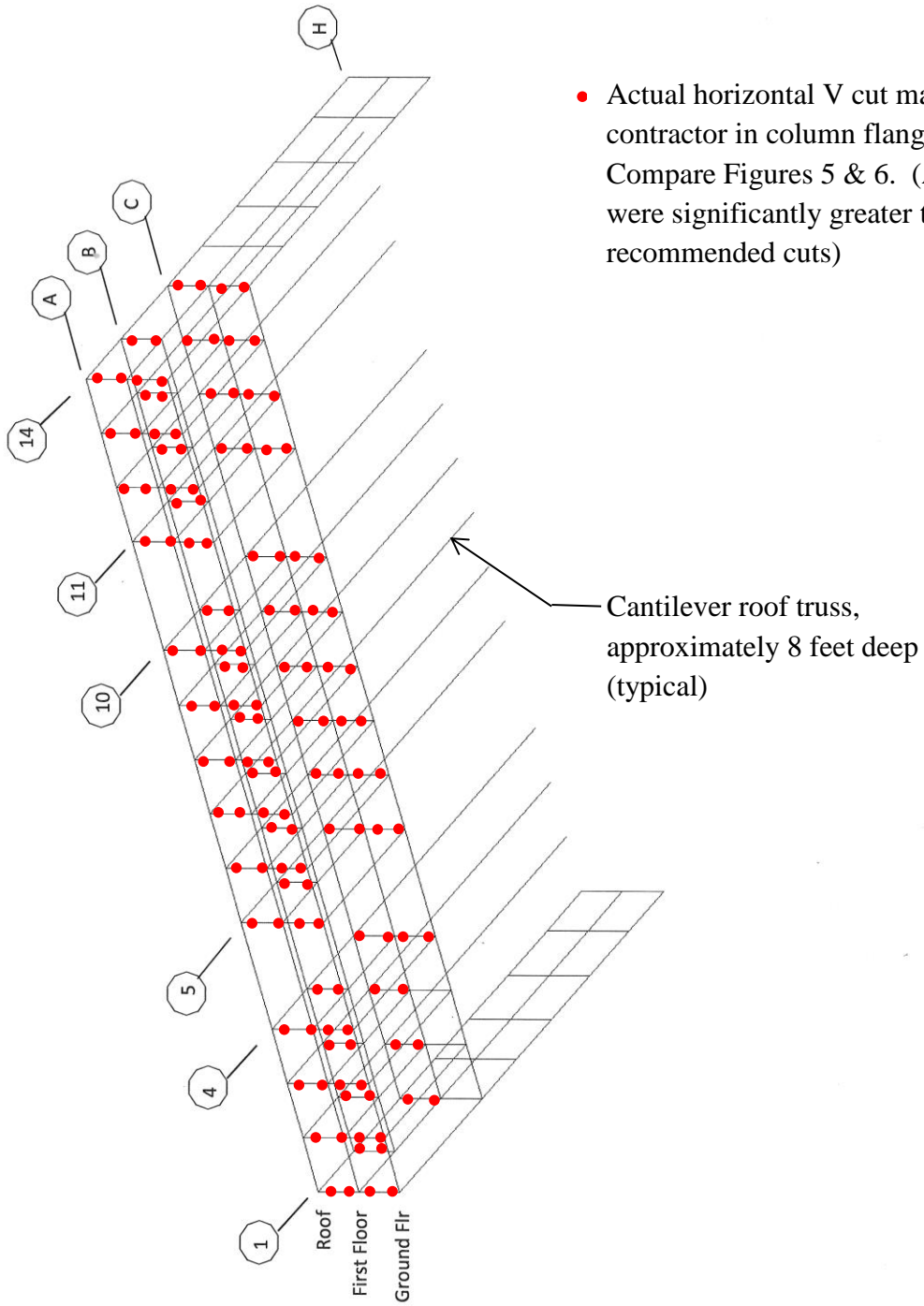


FIGURE 6

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Partial west view
FIGURE 7



Partial west view
FIGURE 8



Partial west view at column line A14
FIGURE 9



Partial west view
FIGURE 10



Partial west view
FIGURE 11



Partial west view
FIGURE 12

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Partial west view
FIGURE 13



Partial north view from column line A14
FIGURE 14



Partial north view
FIGURE 15



Partial north view
FIGURE 16



Partial north view
FIGURE 17



Partial east view
FIGURE 18

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Partial north-east view from column line H14
FIGURE 19



Partial east view at column line H14
FIGURE 20



Partial east view where roof held by excavator
FIGURE 21



Partial east view where excavator trapped
FIGURE 22



Partial east view for cantilever truss
FIGURE 23



Partial east view for cantilever truss
FIGURE 24

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Partial south view from column line A1
FIGURE 25



Partial south view
FIGURE 26



Partial south view
FIGURE 27



Partial south-west view from column line A1
FIGURE 28



Partial west view from column line A1
FIGURE 29

Catanzaro & Sons Enterprises

ENGINEERED COLLAPSE – SEQUENCE OF EVENTS

BUILDING 14

BREWSTER ROAD – NEWARK LIBERTY INTERNATIONAL AIRPORT
NEWARK , NJ

CATANZARO & SONS ENTERPRISES / CATCO

10 GREGORY DRIVE
MONTVILLE , NJ 07045

September 22, 2015

DESCRIPTION:

1. CATCO has been contracted as a sub- contractor to VRH for the demolition of building 332-95 and 14 located at the above referenced address.
2. The PORT AUTHORITY OF NY AND NJ has jurisdiction over this project and had required an engineered demolition plan for the demolition of the buildings listed above .
3. CATCO had submitted an engineered demolition plan prepared by BERTIN ENGINEERING at the onset of this project ; the plan included conventional demolition methods to be implemented for all 3 buildings. The plan was approved by the PA for Buildings 332 & 95 but was not approved for Building 14.
4. CATCO proceeded with the demolition of Buildings 332 & 95 and completed the demolition of these buildings in a safe and timely manner.
5. During the course of the Building 95 Demolition, CATCO & BERTIN ENGINEERING formulated a new Demolition Plan for Building 14 which included an engineered collapse .
6. Upon approval of the engineered collapse method , CATCO prepared the interior of Building 14 which included the removal of all office partitions and loose debris on the second and first floors of the 2 story section as well as removal of non load bearing CMU walls dividing the 2 story section from the Hangar section of the building and CMU / Brick exterior walls / hangar doors .
7. Upon completion of the interior “shell out” CATCO turned the building over to VRH for the process of lead paint abatement on the columns to be pre-cut for the engineered collapse. (Approx. 2 weeks)
8. Upon the removal of all lead paint abatement – CATCO re-mobilized to commence the engineered collapse operation .
9. On September 8, 2015 – CATCO began the preparation of the engineered collapse which included stringing all pull cable around the columns located on column line C 1 through 14.

10. The plan included 4 points of cable pulling connected to 4 hydraulic excavators. The Excavators would be staged on the West end of Building 14 and connected to the 14 columns of column line C – divided into 4 groups.
11. During the course of the day on September 8, 2015 – CATCO completed the cable connections and continued with other tasks including loading out remaining scrap piles from the removal of interior fixtures / hangar doors .
12. On September 9 , 2015 – CATCO began the torch cutting pre-cuts to prepare the Building for Engineered Collapse scheduled for 7:00 a.m. September 10, 2015.
13. CATCO had 4 men cutting with torches , 1 Safety officer , 1 Supervisor / Competent person and 2 additional fire watch personnel.
14. Cutting began on the 2nd floor working from the South to the North and continuing on the 1st floor in the same manner.
15. During the course of the torch cutting operation , the competent person closely observed the structure looking for any signs of deflection in the pre- cut columns throughout the course of the day.
16. By lunch time , 90% of the cuts where completed .
17. After lunch break , cutting continued beginning on the ground floor. The structure still had not changed in any manner at this time including no deflection in any of the pre-cut columns .
18. The last column on the second floor was completed and the 3 personnel on the second floor where preparing to return to the ground floor, 1 cutter was positioned approx. 12' – 15' off of the ground floor in a boom lift cutting the top cuts of column line C below the second floor approx. mid building , The Safety officer , Super , 1 fire watch and 1 cutter where on the ground floor adjacent to column line C in the North end of the Hangar. The first of the low cuts on column line C was performed and this was the first column to show any sign of deflection, The competent person noticed approx. 2" of deflection in this column (13C) and immediately began the process of stopping all work and regrouping – within 10 seconds of this taking place, the entire structure collapsed.
19. Immediately following the collapse , all personnel was accounted for and properly treated for non-life threatening injuries.