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Development and Evaluation of Safety Orange Airport Construction Signage

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October 2015

Final Report

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16. Abstract In April 2010, the Federal Aviation Administration (FAA) Air Traffic Organization created the Airport Construction Advisory Council (ACAC) to identify hazards due to airfield construction activities. The ACAC has recently proposed the use of safety orange for temporary airport construction signage to reduce adverse operational incidents. In response to this proposal, the Airport Technology Research and Development Branch researchers from the William J. Hughes Technical Center visited ongoing airport construction projects and collected information to identify shortfalls and determine compliance with related Advisory Circulars (AC). They were also tasked to develop and evaluate prototype signs in an airport environment. Site visits were conducted to existing construction sites at several airports to collect information regarding the airport's existing airfield construction projects. Pilots of varying backgrounds evaluated several design concepts utilizing the simulation technology of the Airway Facilities Tower Integration Laboratory at the William J. Hughes Technical Center. Outdoor evaluations were then conducted using sign prototypes to determine the optimal height and color used for the sign legend. To validate the final sign prototypes, evaluations were conducted at several airports where construction projects were occurring. No shortfalls with respect to compliance with the related ACs were identified during the site visits. Several types of visual aids were used at the airports in accordance with AC 150/5370-2F. The airport operators indicated that besides using the current visual aids, found in AC 150/5370-2F, the use of the temporary safety orange signs would be advantageous if they were available. During the field evaluations of the prototype signs, a combined total of 131 individuals participated in the survey, including 98 vehicle operators and 33 pilots. Overall, vehicle operators and pilots overwhelmingly agreed the messages, character heights, and colors of the signs were comprehensible, conspicuous, and adequate in alerting individuals about existing construction. Based on the results of this study, it is advised that AC 150/5370-2F be updated to include safety orange construction signage as a visual aid to alert pilots and vehicle operators of existing airport construction. Signs displaying CONSTRUCTION ON RAMP and CONSTRUCTION AHEAD are recommended to be placed at locations leading to ramps and other areas with construction activity. When a runway is temporarily shortened due to construction, it is recommended that TAKEOFF RUN AVAILABLE (TORA) signs be placed at the runway entrances to display the current takeoff run available. Additional education is recommended to increase understanding of the TORA acronym to ensure pilots have adequate situational awareness.					
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TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY	xiii
1. INTRODUCTION	1
1.1 Background	1
1.2 Objectives	2
1.3 Approach	2
2. STAKEHOLDER SURVEY	2
3. REFERENCE MATERIAL REVIEW	4
3.1 Advisory Circulars	4
3.2 Notices to Airmen	5
3.3 National Flight Data Center	5
4. AIRFIELD SITE VISITS	7
4.1 Orlando Sanford International Airport	7
4.2 Valkaria Airport	9
5. WILLIAM J. HUGHES TECHNICAL CENTER EVALUATIONS	10
5.1 Airway Facilities Tower Integration Laboratory	11
5.1.1 Overview	11
5.1.2 Test Descriptions	11
5.1.3 Results	14
5.2 Legend Height and Color Evaluation	23
5.2.1 Overview	24
5.2.2 Results	24
6. FINAL SIGN DESIGNS	26
6.1 Legend Text	26
6.1.1 Construction Ahead	27
6.1.2 Construction on Ramp	27
6.1.3 Takeoff Run Available	28
6.2 Sign Fabrication	30

7.	AIRPORT EVALUATIONS	32
7.1	Long Island MacArthur Airport	33
7.1.1	Installation	33
7.1.2	Results	36
7.2	Theodore Francis Green State Airport	38
7.2.1	Signage Installation	38
7.2.2	Evaluation Results	41
7.3	Chicago O'Hare International Airport	44
7.3.1	Signage Installation	44
7.3.2	Evaluation Results	46
7.4	Portland International Airport	48
7.4.1	Signage Installation	48
7.4.2	Evaluation Results	52
7.5	Orlando Sanford International Airport	57
7.5.1	Signage Installation	57
7.5.2	Evaluation Results	60
7.6	John F. Kennedy International Airport	63
7.6.1	Signage Installation	63
7.6.2	Evaluation Results	66
7.7	Summary—Airport Evaluations	70
8.	CONCLUSIONS	75
9.	RECOMMENDATIONS	76
10.	REFERENCES	77

APPENDICES

- A—Airport Operator Questions
- B—Orlando Sanford International Airport Operator Site Visit Questions
- C—Valkaria Airport Operator Site Visit Questions
- D—Safety Orange Presentation Slide Comment Form

E—Character Color and Legend Height Evaluation
F—Pilot Evaluation Airway Facilities Tower Integration Laboratory
G—Long Island MacArthur Airport Vehicle Operator Evaluation
H—Theodore Francis Green State Airport Vehicle Operator Evaluation
I—Chicago O’Hare International Airport Vehicle Operator Evaluation
J—Portland International Airport Vehicle Operator Evaluation
K—Orlando Sanford International Airport Vehicle Operator Evaluation
L—John F. Kennedy International Airport Vehicle Operator Evaluation

LIST OF FIGURES

Figure	Page
1 Early Stage Sign—TURN HERE	3
2 Early Stage Sign—CAUTION NO LEFT TURN	3
3 Early Stage Sign—TAKEOFF RUN AVAILABLE Acronym With Arrow	3
4 Early Stage Sign—TAKEOFF RUN AVAILABLE Acronym	3
5 Portland International Airport Construction NOTAM	5
6 Chicago O’Hare Construction Notice Depicted on NFDC	6
7 Temporary Relocated Runway Threshold Markings and Turn-Around Centerline	8
8 Temporary Turn-Around Centerline Layout From Phasing Plan	8
9 Barricades on Taxiway and Sign Wrapped in Black Visqueen Screen	9
10 Placement of Lighted X and Yellow Fabric X	10
11 Placement of the Barricades on the Runway	10
12 Controls Used by Subject Pilots During Simulated Scenarios	12
13 CONSTRUCTION AHEAD Signs	12
14 CONSTRUCTION ON RAMP Signs	12
15 TAKEOFF RUN AVAILABLE Signs	13
16 Additional Signage	13
17 Run 2 Simulated CONSTRUCTION AHEAD Sign During Daytime Conditions	14
18 Run 2 Simulated TORA Sign With Black Character Legend During Daytime Conditions	15
19 Run 2 Simulated TORA Sign With White Character Legend During Daytime Conditions	15
20 Run 2 Simulated TORA Sign With Black and White Character Legends During Daytime Conditions	15
21 Run 3 Simulated CONSTRUCTION AHEAD Sign During Nighttime Conditions	17

22	Run 3 Simulated TORA With Runway Designation Sign During Nighttime Conditions	17
23	Run 4 Simulated CONSTRUCTION 600 FT AHEAD Sign During Daytime Conditions	18
24	Run 4 Simulated TORA 8750 FT With Arrow Sign During Daytime Conditions	18
25	Run 5 Simulated CONSTRUCTION 600 FT AHEAD Sign During Nighttime Conditions	20
26	Run 5 Simulated TORA With Arrow Sign With Black Character Legend During Nighttime Conditions	20
27	Run 5 Simulated TORA With Arrow Sign With White Character Legend During Nighttime Conditions	20
28	Run 5 Simulated TORA Sign With Black and White Character Legends During Nighttime Conditions	21
29	Run 6 Simulated CONSTRUCTION ON RAMP Sign During Daytime Conditions	22
30	Run 7 Simulated CONSTRUCTION ON RAMP Sign Collocated With Sign Array During Daytime Conditions	23
31	Run 7 Simulated CONSTRUCTION ON RAMP Sign Collocated With Sign Array During Daytime Conditions	23
32	Daytime Tests at the William J. Hughes Technical Center—With Black and White 8-in. and 9-in. Character Legends	24
33	Nighttime Tests at the William J. Hughes Technical Center—With Black and White 8-in. and 9-in. Character Legends	26
34	CONSTRUCTION AHEAD Sign Legend	27
35	CONSTRUCTION ON RAMP Sign Legend	28
36	The TORA Sign Legend Evaluated at PDX	29
37	The TAKEOFF RUN AVAILABLE Sign Legend Evaluated at JFK	29
38	Base Stand and Frangible Coupling	30
39	Frangible Coupling Tether	31
40	Attachment of Legs to Sign Panel	31
41	Weighted Barrier Positions	32

42	Tethers on Weighted Barriers	32
43	Overview of Safety Orange Construction Sign Locations at ISP	34
44	CONSTRUCTION AHEAD Sign From TWY S View at ISP	35
45	CONSTRUCTION AHEAD Sign as Observed on RWY 10 at ISP	36
46	Overview of Safety Orange Construction Sign Locations at PVD	39
47	CONSTRUCTION AHEAD Sign on TWY T at PVD	39
48	CONSTRUCTION ON RAMP Sign on TWY A at PVD	40
49	Overview of Safety Orange Construction Sign Locations at ORD	45
50	CONSTRUCTION AHEAD Sign on TWY C1 at ORD	46
51	CONSTRUCTION AHEAD Sign on TWY Z at ORD	46
52	Overview of Safety Orange Construction Sign Locations at PDX	49
53	CONSTRUCTION AHEAD Sign on TWY C at PDX	50
54	The RWY 28L TORA 8560 FT Sign at PDX	51
55	CONSTRUCTION ON RAMP Sign at PDX	52
56	Overview of Safety Orange Construction Sign Locations at SFB	58
57	CONSTRUCTION AHEAD Sign on North Side of the Terminal Apron at SFB	59
58	CONSTRUCTION ON RAMP Sign on the South Side of the Terminal Apron at SFB	59
59	Sign Locations at JFK	63
60	Sign Schedule at JFK	64
61	CONSTRUCTION AHEAD Sign at JFK	65
62	TAKEOFF RUN AVAILABLE Sign on TWY YA at JFK	65
63	TAKEOFF RUN AVAILABLE Sign at RWY 4L Entrance at JFK	66

LIST OF TABLES

Table	Page
1 Vehicle Operator Results for ISP TWY S—CONSTRUCTION AHEAD Sign	37
2 Vehicle Operator Results for ISP RWY 10—CONSTRUCTION AHEAD Sign	38
3 Vehicle Operator Results for PVD TWY T—CONSTRUCTION AHEAD Sign	41
4 Vehicle Operator Results for PVD TWY A—CONSTRUCTION ON RAMP Sign	42
5 Pilot Results for PVD TWY T—CONSTRUCTION AHEAD Sign	43
6 Pilot Results for PVD TWY A—CONSTRUCTION ON RAMP Sign	44
7 Vehicle Operators Results for ORD TWY C1—CONSTRUCTION AHEAD Sign	47
8 Vehicle Operator Results for ORD TWY Z—CONSTRUCTION AHEAD Sign	48
9 Vehicle Operator Results for PDX TWY C—CONSTRUCTION AHEAD Sign	53
10 Vehicle Operator Results for PDX TWY E5—CONSTRUCTION ON RAMP Sign	54
11 Vehicle Operator Results for PDX TWY C6—RWY 28L TORA 8560 FT Sign	55
12 Pilot Results for PDX TWY C—CONSTRUCTION AHEAD Sign	56
13 Pilot Results for PDX TWY E5—CONSTRUCTION ON RAMP Sign	57
14 Vehicle Operator Results for the SFB South Side—CONSTRUCTION AHEAD Sign	60
15 Vehicle Operator Results for the SFB North Side—CONSTRUCTION ON RAMP Sign	61
16 Pilot Evaluation Results for the SFB North Side—CONSTRUCTION ON RAMP Sign	62
17 Pilot Results for JFK—TAKEOFF RUN AVAILABLE Sign	67
18 Vehicle Operator Results for JFK—TAKEOFF RUN AVAILABLE Sign	68
19 Pilot Results for JFK—CONSTRUCTION AHEAD Sign	69
20 Vehicle Operator Results for JFK—CONSTRUCTION AHEAD Sign	70
21 Combined Vehicle Operator Results—CONSTRUCTION AHEAD Sign	71

22	Combined Vehicle Operator Results—CONSTRUCTION ON RAMP Sign	72
23	Combined Pilot Results—CONSTRUCTION AHEAD Sign	73
24	Combined Pilot Results—CONSTRUCTION ON RAMP Sign	74
25	Combined Results—TORA Signage	75

LIST OF ACRONYMS

AC	Advisory Circular
ACAC	Airport Construction Advisory Council
AFTIL	Airway Facilities Tower Integration Laboratory
ALPA	Air Line Pilots Association
ARFF	Aircraft Rescue and Fire Fighting
ASDA	Accelerated Stop Distance Available
BMX	Bicycle motocross
CSPP	Construction Safety Phasing Plan
FAA	Federal Aviation Administration
GA	General aviation
ISP	Long Island MacArthur Airport
JFK	John F. Kennedy International Airport
NAS	National Airspace System
NFDC	National Flight Data Center
NOTAM	Notices to Airmen
ORD	Chicago O'Hare International Airport
PDX	Portland International Airport
PVD	Theodore Francis Green State Airport
R&D	Research and Development
RWY	Runway
SFB	Orlando Sanford International Airport
TORA	Takeoff Run Available
TWY	Taxiway
X59	Valkaria Airport

EXECUTIVE SUMMARY

In April 2010, the Federal Aviation Administration (FAA) Air Traffic Organization created the Airport Construction Advisory Council (ACAC) to identify hazards due to airfield construction activities. The ACAC has recently proposed the use of safety orange as the color of temporary airport construction signage to aid in reducing adverse operational incidents. In response to this proposal, the FAA Airport Engineering Division requested that the Airport Technology Research and Development (R&D) Branch at the William J. Hughes Technical Center visit ongoing airport construction projects and collect information to identify shortfalls and determine compliance with related Advisory Circulars (ACs). The Airport Technology R&D Branch was also tasked to develop and evaluate prototype signs in an airport environment. Site visits were conducted to existing construction sites at several airports to collect information regarding the airport's existing airfield construction projects. At the William J. Hughes Technical Center, pilots of varying backgrounds evaluated several design concepts utilizing the simulation technology of the Airway Facilities Tower Integration Laboratory (AFTIL). Outdoor evaluations were then conducted using sign prototypes to determine the optimal height and color used for the sign legend.

To validate the final sign prototypes, evaluations were conducted at the following airports: Chicago O'Hare International Airport (ORD) in Chicago, Illinois; Portland International Airport (PDX) in Portland, Oregon; Theodore Francis Green State Airport (PVD) in Warwick, Rhode Island; Long Island MacArthur Airport (ISP) in Ronkonkoma, New York; Orlando Sanford International Airport (SFB) in Sanford, Florida; and John F. Kennedy International Airport (JFK) in New York, New York.

No shortfalls with respect to compliance with the related ACs were identified during the site visits. Several types of visual aids were used at the airports in accordance with AC 150/5370-2. The airport operators indicated that besides using the current visual aids, found in AC 150/5370-2F, the use of the temporary safety orange signs would be advantageous if it were available. During the field evaluations of the prototype signs a combined total of 131 individuals participated in the survey, including 98 vehicle operators and 33 pilots. Overall, vehicle operators and pilots overwhelmingly agreed the messages, character heights, and colors of the signs were comprehensible, conspicuous, and adequate in alerting individuals about existing construction.

Based on the results of this study, it is recommended that AC 150/5370-2 be updated to include safety orange construction signage as a visual aid to alert pilots and vehicle operators of existing airport construction. Signs displaying CONSTRUCTION ON RAMP and CONSTRUCTION AHEAD are recommended to be placed at locations leading to ramps and other areas with construction activity. When a runway is temporarily shortened due to construction, it is recommended that signs indicating takeoff run available (TORA) be placed at the runway entrances to display the current takeoff run available. Pilots and vehicle operators found both the legend text TORA and the legend text TAKEOFF RUN AVAILABLE acceptable for use on TORA signage. However, due to the increased length of the sign panel necessary to

accommodate the additional characters of TAKEOFF RUN AVAILABLE, it is recommended that acronym TORA be specified in the final sign design. Additionally, it is recommended that the size of the signs should be 30 in. high by 84 in. wide, and the near side of the sign should be placed approximately 36 feet perpendicular to the taxiway pavement edge. Finally, it is recommended that additional education be conducted to increase understanding of the TORA acronym to ensure pilots have adequate situational awareness.

1. INTRODUCTION.

This report describes the research and development effort to evaluate the concept of using temporary safety orange signs during construction to aid in reducing adverse airport incidents. Additionally, this report describes the research and design process, evaluation findings, and recommended specifications for this signage.

1.1 BACKGROUND.

Construction projects at airports create a number of safety challenges, particularly when these construction activities occur in the movement areas of the airport (i.e., taxiways and runways). For instance, airport construction can often require the closure of one or more taxiways, having a significant effect in altering the taxi routes that aircraft normally follow to and from runways. Such closures may occur abruptly and unexpectedly, further reducing a pilot's situational awareness. Additionally, an airport may close a runway or displace an existing runway threshold when construction activity occurs in the vicinity of a runway, leaving some pilots unaware of the reduced distance available on the runway. Over the past 15 years, airport construction activities have been a contributing factor in several serious incidents and accidents at airports, such as those occurring at Chicago O'Hare International Airport in Chicago, Illinois (2009), Blue Grass Airport in Lexington, Kentucky (2006), Taiwan Taoyuan International Airport in Taiwan (2000), and Vienna International Airport in Vienna, Austria (1997) [1].

In April 2010, responding to the safety risk posed by airport construction, the Federal Aviation Administration (FAA) Air Traffic Organization created the Airport Construction Advisory Council (ACAC) to identify hazards on airfields during construction activities. As stated in its 2012 article entitled, "What's on Your Runway?": "The ACAC consists of FAA and aviation industry professionals with diverse backgrounds and experience." [1] Initial efforts of the ACAC "targeted operations on runways shortened due to construction and situations where the combination of aircraft, construction vehicles, workers, broken pavement and sometimes other substantial activities can create significant risk." [1]

In addition to identifying hazards of airfield construction activities, ACAC also proposed potential solutions for mitigating these hazards, such as air traffic control alerting pilots of airport construction via automated terminal information service broadcasts and revising takeoff clearances to remove the words full length and mentioning the shortened runway. Standardizing the management of air traffic operations during airport construction operations is another goal. To this end, ACAC proposed the use of safety orange as the color of temporary airport construction signage to aid in reducing in adverse operational incidents. In response to this proposal, the FAA Airport Engineering Division (AAS-100) requested that the Airport Technology Research and Development (R&D) Branch initiate the research project and coordinate with ACAC and other FAA Offices including Air Traffic, Flight Standards District Office, Runway Safety Office, and Technical Operations to review and test the proposed measures recommended by the ACAC.

1.2 OBJECTIVES.

The specific research objectives of this project were to

1. collect data from current construction projects at airports to identify shortfalls at existing construction sites and to determine whether they comply with related construction Advisory Circulars (ACs).
2. develop and evaluate safety orange airport construction signage and reflective/portable visual aids to reduce adverse operational incidents during construction.
3. provide conclusions and recommendations derived from the signage evaluations.

These objectives were designed to fully investigate the most appropriate signage needed for vehicle operators and aircraft operating at an airport with airfield construction.

1.3 APPROACH.

This research effort used several different evaluation methods. In the preliminary phase of the project, a survey distributed to airport stakeholders was used to obtain initial feedback on potential sign concepts. Next, reference materials related to airport construction were reviewed, including ACs, Notices to Airmen (NOTAMS), and information from the National Flight Data Center (NFDC). Airport site visits were conducted in the early stage of research to determine if improvement for identifying construction areas was needed. To refine the sign designs, simulated outdoor evaluations with mock signs were conducted at the FAA William J. Hughes Technical Center, near Atlantic City, New Jersey. Finally, the most effective sign designs from the William J. Hughes Technical Center evaluations were fabricated and installed at six airports for final evaluation. These airports included: Chicago O'Hare International Airport (ORD) in Chicago, Illinois; Portland International Airport (PDX) in Portland, Oregon; Theodore Francis Green State Airport (PVD) in Warwick, Rhode Island; Long Island MacArthur Airport (ISP) in Ronkonkoma, New York; Orlando Sanford International Airport (SFB) in Sanford, Florida; and John F. Kennedy International Airport (JFK) in New York, New York. Online and paper opinion surveys were distributed to pilots and vehicle operators at each airport to determine to what degree they thought the signs were conspicuous, comprehensible, and provided adequate notice of existing construction.

2. STAKEHOLDER SURVEY.

In the early phase of this research effort, researchers surveyed several airport operators, vehicle operators, and pilots, for their opinion on perspective signs that should be evaluated. These groups were initially shown the proposed, ACAC-recommended signs and asked to provide feedback. Figures 1 through 4 (not to scale) show examples of these signs. In addition, these groups were asked, "besides using the current visual aids/markings, which of these additional signs would be useful during a construction project?"



Figure 1. Early Stage Sign—TURN HERE



Figure 2. Early Stage Sign—CAUTION NO LEFT TURN



Figure 3. Early Stage Sign—TAKEOFF RUN AVAILABLE Acronym With Arrow



Figure 4. Early Stage Sign—TAKEOFF RUN AVAILABLE Acronym

The airport operators, vehicle operators, and pilots concluded that the early-stage signs presented were confusing, with the exception of the TAKEOFF RUN AVAILABLE (TORA) signs. Some pilots noted that the TORA sign should have the runway designation added to help pilots discern what runway the TORA is referencing.

Several individuals commented that airfield signs should not contain pictures, and character legends should be the same font as existing airfield signs. Other comments taken from the forms distributed during the evaluation included: “too much going on within the signs, information overload,” “need clear interpretation,” and “signs resemble highway signs.” Several individuals commented to keep the message simple.

Other individuals suggested that ramp construction should be identified by a CONSTRUCTION ON RAMP sign. In addition, individuals suggested construction on ramps or taxiways should include signs that say CONSTRUCTION AHEAD or add a distance to the construction area with the message; for example, CONSTRUCTION 500 FEET AHEAD. One comment suggested the purpose of the CONSTRUCTION AHEAD sign should be to provide ample distance so that a pilot or vehicle operator does not miss the last turn to exit off. These types of messages would be easy to process, clear, and concise, unlike the messages of the signs shown in figures 1 and 2.

Next, researchers discussed the prospective signs with the airport operators from ORD, PDX, PVD, SFB, ISP, and JFK to be tested at each airport. The airport operators agreed that having some form of TORA, CONSTRUCTION AHEAD, and CONSTRUCTION ON RAMP signs, would provide additional information regarding construction occurring on the airfield to pilots and vehicle operators. The airport operators expressed that the messages were clear, easy to interpret, and would not be information overload on either the pilot or vehicle operator. Once the sign messages were narrowed down, pilots validated them at the Airway Facilities Tower Integration Laboratory (AFTIL) located at the William J. Hughes Technical Center through simulation.

3. REFERENCE MATERIAL REVIEW.

Part of this research effort involved a review of reference materials, which included ACs, NOTAMS, NFDC information, and other sources of information available to airport users for identifying the presence of an airfield construction project at a particular airport. This section provides a description and example of each of these sources as they pertain to this research.

3.1 ADVISORY CIRCULARS.

AC 150/5370-2F states: “aviation safety is a primary consideration at airports, especially during construction.” [2] The airport operator’s Construction Safety Phasing Plan (CSPP) and the contractor’s Safety Phasing Plan Compliance Document are the primary tools to ensure safety compliance when coordinating activities with airport operators. [2]

Within Sections 218 “Runway and Taxiway Visual Aids” and 220, “Hazard, Marking, Lighting and Signage” of AC 150/5370-2F, the text refers to how construction areas on the airfield should be marked with specific visual aids. [2]

3.2 NOTICES TO AIRMEN.

The Notices to Airmen (NOTAM) system provides essential information to personnel concerned with flight and airport operations. NOTAMs provide timely information on unanticipated or temporary changes to components of, or hazards in, the National Airspace System (NAS). Component changes may pertain to facilities, services, procedures, or hazards in the NAS. A NOTAM provides information that becomes available too late to publicize in the associated aeronautical charts and related publications. AC 150/5200-28D [3] provides guidance on how to use the NOTAM system.

AC 150/5370-2 states with regard to NOTAMs:

“...the airport operator must coordinate the issuance, maintenance, and cancellation of NOTAMS about airport conditions resulting from construction activities with tenants and the local air traffic facility and must provide information on closed or hazardous conditions on airport movement areas to the FAA Flight Service Station (FSS) so it can issue a NOTAM...” [2]

Figure 5 shows an example of a NOTAM issued by an airport operator regarding construction occurring on the south ramp at PDX.

!PDX 05/011 (KPDX A0285/13) PDX APRON SOUTH RAMP WORK IN PROGRESS CONST TAXILANE E5 REALIGNED WEF 1305082144-1310182300 !PDX 04/060 (KPDX A0262/13) PDX APRON SOUTH RAMP WORK IN PROGRESS CONST FLAGGING OPERATION WEF 1305011430-1310182300

Figure 5. Portland International Airport Construction NOTAM

3.3 NATIONAL FLIGHT DATA CENTER.

The NFDC website also provides airport construction notices to depict construction activities on airports, as shown in figure 6. The disclaimer located on the bottom of the construction notice shown in figure 6 states:

“This diagram is intended to display NOTAMs and is checked and updated daily (Mon – Fri only; no holidays); temporary closures/openings of less than 24 hours are not depicted; runway length shown is maximum length (shortened distances are not depicted); diagrams containing new runway surfaces will be deleted after (FAA) revised airport diagrams are published. Always CHECK CURRENT NOTAMs”

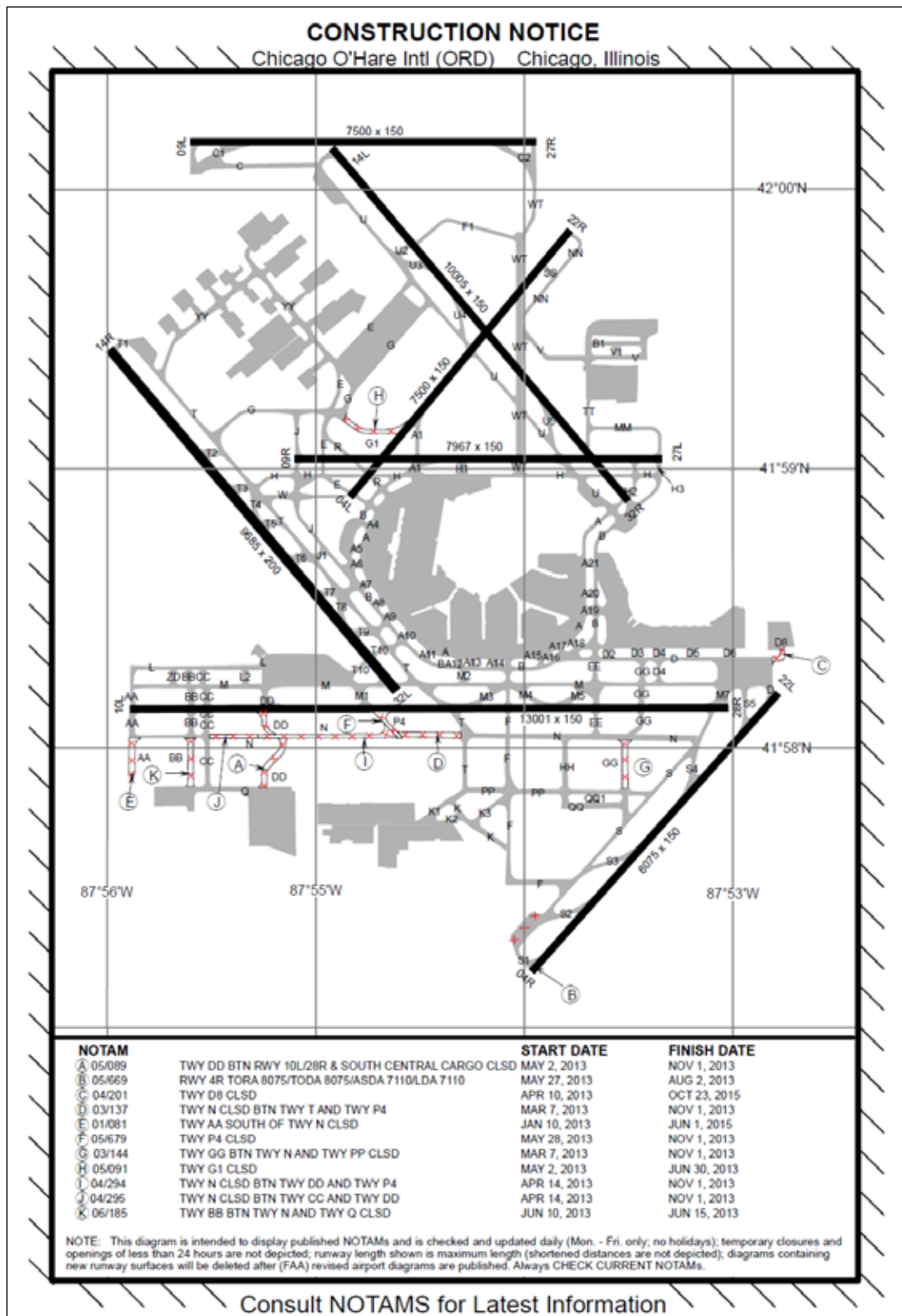


Figure 6. Chicago O'Hare Construction Notice Depicted on NFDC

4. AIRFIELD SITE VISITS.

Researchers conducted site visits to Orlando Sanford International Airport (SFB) in Sanford, Florida, and Valkaria Airport (X59) in Grant-Valkaria, Florida, to collect information regarding the airports' existing airfield construction projects. Site visits consisted of a meeting with the airport operator and receiving an airfield tour of the area that had the construction project in progress. During each site visit, the researchers asked the airport operator specific questions, provided in appendix A, regarding background information on the airport's construction projects and if the airport was complying with AC 150/5370-2, especially the CSPP. Note: The purpose of this visit was to determine the need for improvement in alerting pilots and vehicle operators to the presence of construction areas.

Both site visits indicated that improvement was needed. It was determined that additional signage would add an additional level of safety to notify pilots and vehicle operators prior to approaching construction areas and of shortened runways due to construction. After visiting these airports, the researchers did not identify any shortfalls with respect to compliance with the related ACs.

4.1 ORLANDO SANFORD INTERNATIONAL AIRPORT.

On March 7, 2013, researchers visited SFB and were informed that SFB's construction projects consisted of the following:

- Extension of Runway (RWY) 9L/27R from 9,601 feet to 11,000 feet
- Extension of Taxiway (TWY) B from RWY 18/36 to the end of RWY 27R
- Demolish TWY B5 and reconstruct TWY B8
- Construct TWY B10

The airport operator informed the researchers that the construction projects started on August 6, 2012. The airport operator provided copies of the general notes page and the CSPP for the RWY 9L-27R extension. The airport operator answered questions, provided in appendix B, regarding the airport's construction projects. SFB's management team escorted the researchers onto the airfield to view the RWY 9L-27R extension project in progress.

SFB's management team informed the researchers that RWY 27R had a temporary, relocated threshold of 7754 feet. Researchers were also informed that the temporary threshold was put in place to allow the aircraft to back taxi on the runway and turn around past the temporary threshold markings. The aircraft would follow the yellow line to align up with RWY 27R, as shown in figures 7 and 8.



Figure 7. Temporary Relocated Runway Threshold Markings and Turn-Around Centerline

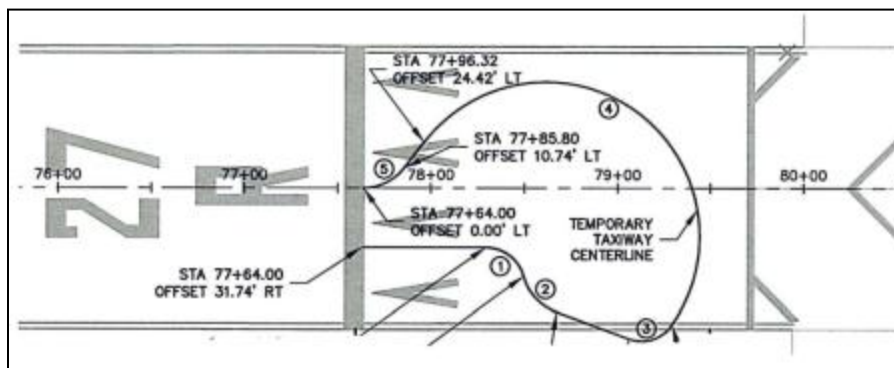


Figure 8. Temporary Turn-Around Centerline Layout From Phasing Plan

The researchers viewed the different visual aids that the airport was currently using in accordance with AC 150/5370-2. As shown in figure 9, these particular visual aids informed pilots and vehicle operators that a particular area was closed. The airport operator informed the researchers that lighted X structures and markings, barricades with red solar-powered lights, and cones were used to identify construction areas, all of which are appropriate means to identify closed runways/taxiways/ramps, as per AC 150/5370-2. Researchers showed the airport operator preliminary safety orange construction signs that were provided by the ACAC and asked if they preferred any of the signs. The airport operator indicated that, in addition to using the current visual aids/markings required by AC 150/5370-2F, the airport preferred the TORA sign for the construction project if it was available. The airport operator expressed that the other preliminary signs shown were not easy to interpret and appeared to be more in line with highway signs instead of airfield signs. It was also suggested that the prototype signs should be clear, more

concise, and provide a simpler message, especially since a pilot or vehicle operator do not have a lot of time to process the information the sign is conveying.



Figure 9. Barricades on Taxiway and Sign Wrapped in Black Visqueen Screen

4.2 VALKARIA AIRPORT.

On March 8, 2013, the researchers who conducted a site visit at X59 were informed that the airport's construction consisted of the following projects:

- Construction of a new taxiway parallel to RWY 14/32. This will be known as TWY A, which will be 25 feet wide.
- Trees were removed to create a pond, which will also serve as a storm water drain (off airfield).
- An old runway that was used during World War II, located in the infield adjacent to RWY 10/28, will be cleared of rocks and used for the bicycle motocross (BMX) track in park area (off airport).

The construction projects started on January 6, 2013. An anticipated completion date for TWY A was slated for June 2013. The airport operator showed the researchers the CSPP for TWY A and provided an electronic copy of it as well. The airport operator answered questions, as shown in appendix C, regarding the airport's construction projects. Furthermore, the airport operator escorted the researchers onto the airfield to observe the TWY A project in progress.

The airport operator informed the researchers that the airport provided three different visual aids on RWY 14/32 to inform the pilots of the runway closure during the TWY A project. The visual aids consisted of (1) a lighted X structure located directly over the runway numbers; (2) a yellow fabric X placed on the centerline with sandbags weighting each corner, located approximately a few hundred feet past the runway numbers; and (3) barricades with red solar lights placed further down the runway. As shown in figures 10 and 11, these particular visual aids informed the pilots and vehicle operators that a particular area was closed. Similar to SFB, X59 used lighted and fabric Xs, barricades with red lights and flags, all of which are in accordance with

AC-150-5370-2F. Researchers showed the airport operator preliminary safety orange construction signs that were provided by ACAC and asked if they preferred any of the signs. The airport operator indicated that, in addition to using the current visual aids/markings required by AC 150/5370-2F, the TORA sign would be beneficial for a construction project if available. The airport operator expressed that the other preliminary signs were not easy to interpret and would be more difficult for vehicle operators and pilots to cognitively process the meaning of the sign message.



Figure 10. Placement of Lighted X and Yellow Fabric X



Figure 11. Placement of the Barricades on the Runway

5. WILLIAM J. HUGHES TECHNICAL CENTER EVALUATIONS.

Two evaluations were conducted at the William J. Hughes Technical Center. The first evaluation consisted of working with the AFTIL. At the AFTIL, pilots evaluated computer-generated runs in a simulator. The runs included various types and locations of construction signage. Pilots validated the message on several safety orange construction signs and whether they preferred the black or white character legend against the orange background.

In the second evaluation, which took place following the sign evaluations at the AFTIL, a team of FAA Airport Safety R&D researchers provided input as to whether black or white character legends were visible and pronounced against the safety orange retroreflective sheeting during daytime and nighttime conditions.

5.1 AIRWAY FACILITIES TOWER INTEGRATION LABORATORY.

The first evaluation for this project used the AFTIL to conduct simulated tests of several proposed sign concepts.

5.1.1 Overview.

Researchers worked with the AFTIL to evaluate several types of signs prior to field evaluations. For testing purposes, the AFTIL simulated the safety orange construction signs on PDX taxiways. PDX was used in the simulated runs because the airport was one of the planned field evaluation airports. All the simulated signs that evaluated at the AFTIL were size-3 sign panels: 30 inches high by 42.5 inches long, with a legend height of 18 inches.

In the first evaluation, pilots evaluated computer-generated runs in a simulator. The runs included various types and locations of construction signage. Pilots validated the message on several safety orange construction signs and indicated whether they preferred the black or white character legend against the orange background.

5.1.2 Test Descriptions.

In July 2013, 17 general aviation (GA), corporate, and airline pilots validated safety orange construction signs at the AFTIL. First, the pilots were briefed with background information on the project and simulated scenarios. Of the 17 pilots, 7 indicated they were not familiar with TORA. Prior to each simulation, the simulator was adjusted depending on the type of pilot. A Cessna 172 was simulated for GA pilots, a Raytheon Hawker was simulated for corporate pilots, and a Boeing 737 was simulated for airline pilots. The aircraft type used during this simulation was important because it determined how the pilot's line of sight would be set.

The simulation scenarios consisted of airport familiarization in which the pilots observed the current markings at PDX and became familiar with the flight controls, as shown in figure 12.



Figure 12. Controls Used by Subject Pilots During Simulated Scenarios

There were seven simulation runs, which presented the following safety orange construction signs a CONSTRUCTION AHEAD (figure 13), CONSTRUCTION ON RAMP (figure 14), or TORA (figure 15). The simulations were run in both daytime and nighttime conditions, with clear visibility (with visibility greater than 10 statute miles and no cloud cover).



Figure 13. CONSTRUCTION AHEAD Signs



Figure 14. CONSTRUCTION ON RAMP Signs

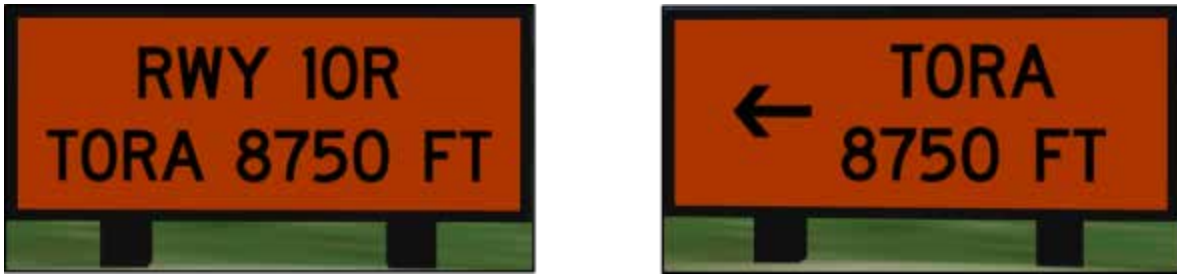


Figure 15. TAKEOFF RUN AVAILABLE Signs

Before the simulated runs, the researchers briefed the pilots on the early stage signs, shown in figures 1 through 4. The researchers collected the pilots' feedback on the signs in an evaluation form, as provided in appendix D.

The pilots concluded that the early stage signs were confusing. One pilot commented, "The early signs are difficult to interpret and could be misleading to pilots. Not recommended. Very difficult to understand." Another pilot stated that the signs were "...no good, could be confusing. Do not look professional. As a pilot, they do not fit in the airfield environment."

Two additional signs were suggested by the FAA, as shown in figure 16 (not to scale).

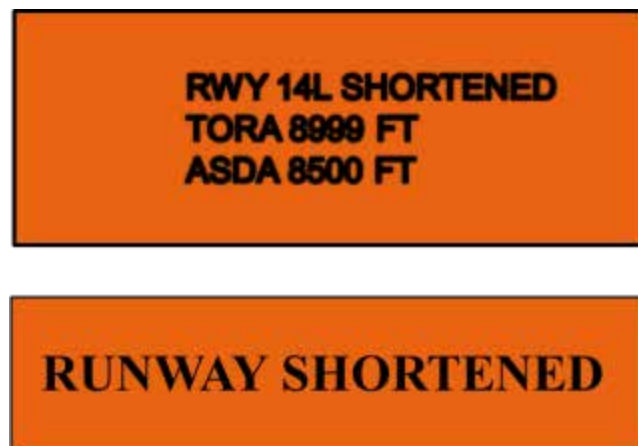


Figure 16. Additional Signage

Several pilots commented that they were not aware of what accelerated stop distance available (ASDA) meant.

Regarding the sign with three lines of text, one pilot commented, "The information should be simplified to reflect only the available runway distance remaining. This is for the benefit of the GA pilots who may be unfamiliar with some of the acronyms." Another pilot indicated "...acronyms TORA and ASDA will be trained by airline pilots and picked up by most corporate pilots. General aviation pilots will be clueless to their meaning."

For the runway shortened sign, several pilots indicated that the message was clear, but left the question as to which runway was in use.

5.1.3 Results.

After each run, the pilots were asked to complete the applicable portion of the evaluation form, provided in appendix F. Each pilot answered the questions for each run based on the specific construction signs that were shown. Of the 17 pilots, 7 indicated they were not familiar with the meaning of the acronym TORA. After the completion of the six runs, the pilots preferred the following messages on the safety orange construction signs: TORA with the runway designation, CONSTRUCTION AHEAD and CONSTRUCTION ON RAMP not collocated with another sign. Pilots did not indicate that any of these additional visual aids created an increase in workload. Of the 17 pilots, 15 preferred the white character legend compared to the black character legend. The pilots indicated the white was visible and more pronounced against the orange background in the simulation.

5.1.3.1 Results of Run 1.

Run 1 was airport and control familiarization, so there was no formal data collected. Once the pilots indicated that they were comfortable with the airport environment and controls, they proceeded to run 2.

5.1.3.2 Results of Run 2.

Run 2 simulated two safety orange construction signs: a CONSTRUCTION AHEAD sign and a TORA sign with runway designation. Run 2 consisted of clear visibility in daylight conditions. The pilots were given taxi instructions to RWY 10R. The pilots proceeded to TWY B from the gate and approached the CONSTRUCTION AHEAD sign, which was located 600 feet prior to the construction activity on TWY B, as shown in figure 17.



Figure 17. Run 2 Simulated CONSTRUCTION AHEAD Sign During Daytime Conditions

The pilots continued on TWY B, turned left onto TWY B2, and held short of RWY 10R. Prior to holding short of RWY 10R, the pilots approached the TORA sign with the runway designation with a black character legend, as shown in figure 18. The TORA sign with the runway designation was angled and located 50 feet from the RWY 28L-10R mandatory holding position sign.

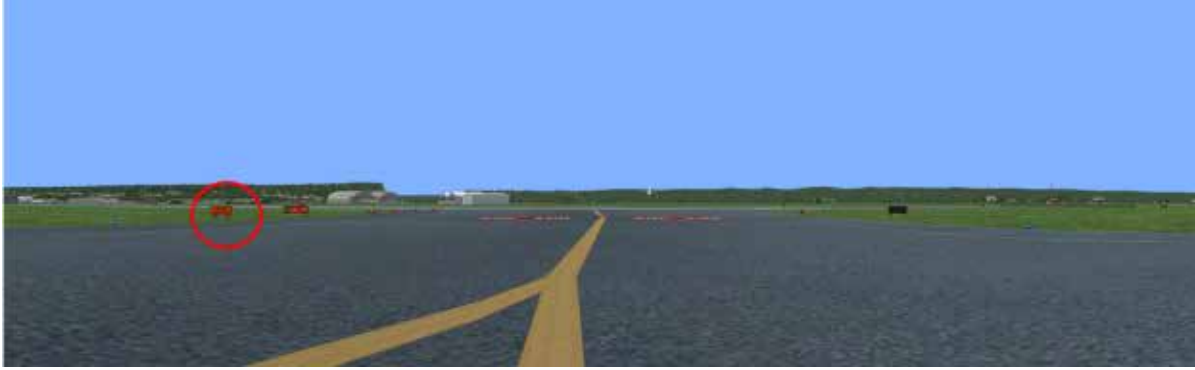


Figure 18. Run 2 Simulated TORA Sign With Black Character Legend During Daytime Conditions

After the pilots viewed the TORA sign with the runway designation that contained the black character legend, they were asked to view the same sign with a white character legend, as shown in figure 19. The subject pilots had the opportunity to compare both black and white character legends, as shown in figure 20.



Figure 19. Run 2 Simulated TORA Sign With White Character Legend During Daytime Conditions

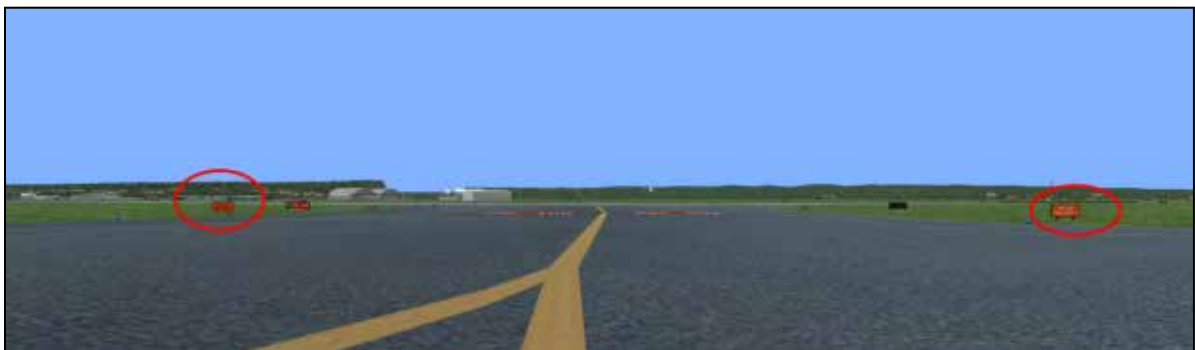


Figure 20. Run 2 Simulated TORA Sign With Black and White Character Legends During Daytime Conditions

The pilots were asked:

- **Run 2—Question 1:** *What does the message on the sign located on TWY B tell you? Was it easy to interpret? What do you think of the message on the sign?*

After a review of the answers provided, there were four comments that were prevalent among the pilots: “easy to interpret/understand,” “clear message,” “did not see,” and “difficult to read.” A summary of those statements are provided in table 2.

- **Run 2—Question2:** *Did you notice the sign prior to stopping? Does the location of the sign need improvement? If so how?*

After a review of the answers provided, two comments were prevalent among the pilots with regard to the location of the sign: “needs to be closer to construction” and “location is good.” With regard to noticing the sign prior to stopping, 12 pilots indicated “yes” and 4 stated “no.” Two pilots proposed that the sign should be placed on both sides.

- **Run 2—Question 3:** *What does the message on the sign located on TWY B2 tell you? Was it easy to interpret? What do you think of the message on the sign?*

Eleven pilots indicated the sign referred to takeoff run available at a specific distance. Ten pilots agreed that the message was easy to interpret.

- **Run 2—Question 4:** *Did you notice the sign prior to stopping? Does the location of the sign need improvement? If so how?*

Nine pilots indicated “yes” and five stated “no” in regards to noticing the sign prior to stopping. Several pilots commented that the sign could have been moved closer. Some pilots noted that signage should be installed on both sides of the taxiway.

- **Run 2—Question 5:** *After observing signs that either have black or white characters on TWY B2, which color character do you prefer? Why?*

After reviewing the comments, 15 pilots preferred the white character legend compared to the black character legend within the simulated environment. Two comments were most prevalent among the pilots with regard to a preference for the white character legend: “stands out more” and “more visible.” A pilot who preferred the black character legend commented that the white character legend is “consistent with road construction sign and overtime will bleed with orange.”

5.1.3.3 Results of Run 3.

Run 3 took place during nighttime conditions, and the visibility was clear. Pilots were provided taxi instructions and told to hold short of RWY 10R at TWY B2. Once the pilots completed this run, an evaluation was completed before continuing onto run 4. During run 3, the pilots observed the same signs as in run 2, as shown in figures 21 and 22.

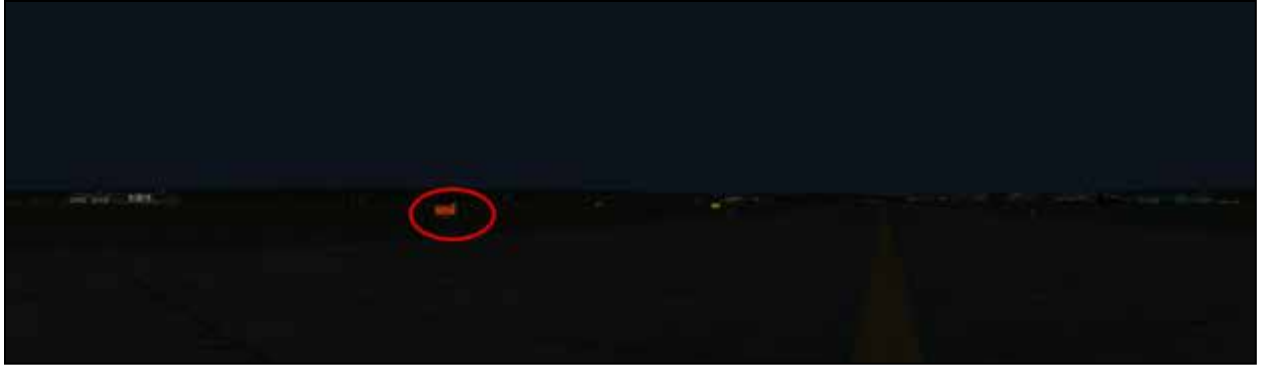


Figure 21. Run 3 Simulated CONSTRUCTION AHEAD Sign During Nighttime Conditions



Figure 22. Run 3 Simulated TORA With Runway Designation Sign During Nighttime Conditions

The pilots were asked:

- **Run 3—Question 1:** *Did night conditions impact the noticeability of the sign? If Yes, how so?*

After reviewing the comments, 16 pilots indicated that nighttime conditions impacted the noticeability of the sign. A common statement made by several pilots was that the sign was more noticeable at night.

5.1.3.4 Results of Run 4.

Run 4 simulated the TORA sign with an arrow and the CONSTRUCTION AHEAD sign with the distance remaining prior to the construction. Run 4 occurred during daytime conditions with clear visibility. The pilots were given taxi instructions to RWY 10R. The pilots proceeded to TWY B from the gate and approached the CONSTRUCTION 600 FEET AHEAD sign, which was located 600 feet prior to the construction activity on TWY B, as shown in figure 23.



Figure 23. Run 4 Simulated CONSTRUCTION 600 FT AHEAD Sign During Daytime Conditions

The pilots continued on TWY B, turned left onto TWY B2, and held short of RWY 10R. Prior to holding short of RWY 10R, the pilots approached the TORA sign with the arrow, as shown in figure 24. The TORA sign with the arrow was at a canted angle and was located 50 feet from the RWY 28L-10R Mandatory Holding Position sign.

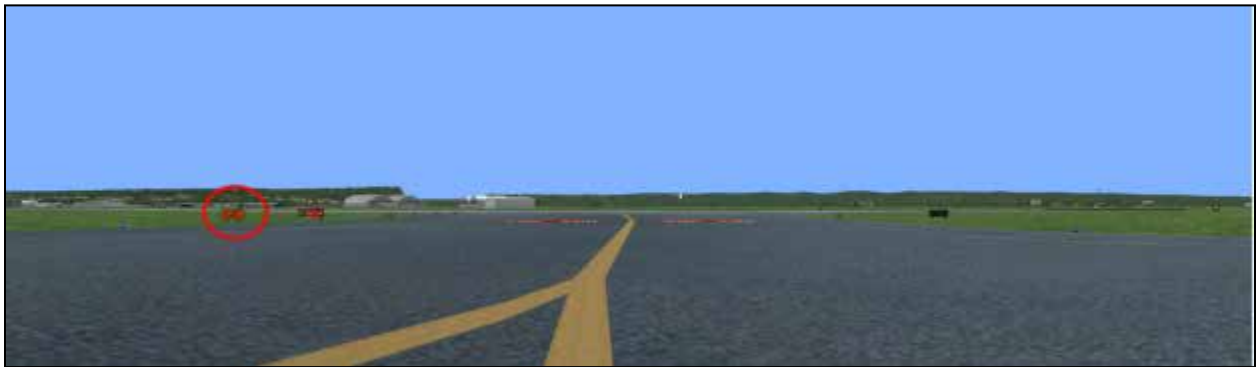


Figure 24. Run 4 Simulated TORA 8750 FT With Arrow Sign During Daytime Conditions

The pilots were asked:

- **Run 4—Question 1:** *What does the message on the sign located on TWY B tell you? Was it easy to interpret? What do you think of the message on the sign?*

The majority of pilots understood the message to be some type of Construction Ahead sign as they were taxiing on TWY B. Several pilots provided comments that it was hard to read and that the numbers were not relevant.

- **Run 4—Question 2:** *Did you notice the sign prior to stopping? Does the location of the sign need improvement? If so, how?*

After reviewing the comments, 13 pilots indicated that that they noticed the sign prior to stopping. Two of the most prevalent comments made by several pilots were that the sign should be closer and on both sides of the taxiway.

- **Run 4—Question 3:** Compared to the “Construction Ahead” sign in the previous run, which message do you prefer and why?

Eleven pilots indicated that they preferred the CONSTRUCTION AHEAD sign compared to the sign that contained the distance. The most prevalent comments provided by several pilots were that the CONSTRUCTION AHEAD sign was simple and straight to the point and that adding a specific distance to the sign was not relevant.

- **Run 4—Question 4:** What does the message on the sign located on TWY B2 tell you? Was it easy to interpret? What do you think of the message on the sign?

Fourteen pilots indicated that the message on the sign denoted some form of the following TORA, TORA 8750, or usable runway. Several pilots mentioned that some pilots may not understand what the acronym TORA means, especially GA pilots.

- **Run 4—Question 5:** Did you notice the sign prior to stopping? Does the location of the sign need improvement? If so how?

Thirteen pilots indicated that they noticed the sign prior to stopping. Several mentioned that the TORA sign with the arrow should be placed on both sides of the taxiway. Two pilots commented that the sign should be located on the right side of the taxiway instead of the left.

- **Run 4—Question 6:** Compared to the TORA sign in the previous run, which message do you prefer and why?

Seven pilots preferred the TORA sign with the runway designation. Several pilots commented that the arrow is redundant and that the reference to the runway was preferred on the sign. Five pilots preferred the TORA with the arrow. One pilot commented that they “...liked the direction made the message clearer.” Thirteen pilots indicated that they noticed the sign prior to stopping. Several pilots mentioned that the TORA sign with the arrow should be placed on both sides of the taxiway. Two pilots commented that the sign should be located on the right side of the taxiway instead of the left.

5.1.3.5 Results of Run 5.

In run 5, the visibility was clear and took place during nighttime conditions. Pilots were provided taxi instructions and told to hold short of RWY 10R at TWY B2. Once the pilots completed this run, an evaluation was completed before continuing onto run 6. During run 5, pilots observed the same signs as in run 4, as shown in figures 25 and 26.

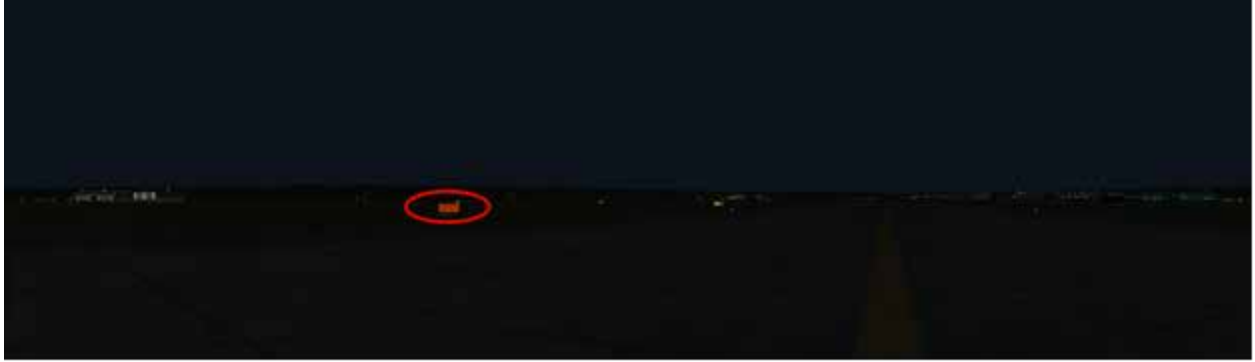


Figure 25. Run 5 Simulated CONSTRUCTION 600 FT AHEAD Sign During Nighttime Conditions



Figure 26. Run 5 Simulated TORA With Arrow Sign With Black Character Legend During Nighttime Conditions

After the pilots viewed the TORA sign with the arrow and the black character legend, they were asked to view the same sign with a white character legend, as shown in figure 27. The pilots had the opportunity to compare both black and white character legends, as shown in figure 28.



Figure 27. Run 5 Simulated TORA With Arrow Sign With White Character Legend During Nighttime Conditions



Figure 28. Run 5 Simulated TORA Sign With Black and White Character Legends During Nighttime Conditions

The pilots were asked:

- **Run 5—Question 1:** *Did nighttime conditions impact the noticeability of the sign? If yes, how so?*

After reviewing the comments, 12 pilots indicated that nighttime conditions impacted the noticeability of the sign. A common statement made by several pilots was that the lighting of the sign made it more noticeable.

- **Run 5—Question 2:** *Sign Comparison-After observing signs that either have black or white characters on TWY B2, which color character do you prefer? Why?*

Fifteen pilots preferred the white character legend compared to the black character legend within the simulated environment. Two comments were most prevalent among the pilots with regard to the pilots' preference for the white character legend: "stands out more" and "easier to read." One pilot who preferred the black character legend commented that the black legend was: "Consistent with highway construction. White lettering looks like mandatory hold sign."

5.1.3.6 Results of Run 6.

Run 6 simulated the CONSTRUCTION ON RAMP sign. Run 6 occurred during daytime conditions with clear visibility. Pilots were given taxi instructions to Gate 23. Construction activity occurred between Gates C9-C20. The pilots proceeded to TWY E3 upon exiting TWY B2 and approached the CONSTRUCTION ON RAMP sign, as shown in figure 29. The CONSTRUCTION ON RAMP sign was at a canted angle and was located 50 feet from the taxiway array sign on TWY E3.

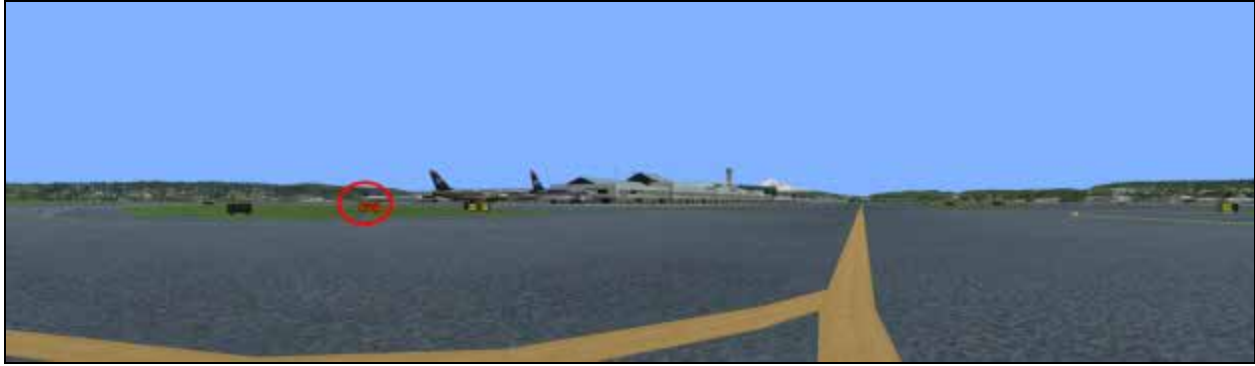


Figure 29. Run 6 Simulated CONSTRUCTION ON RAMP Sign During Daytime Conditions

The pilots were asked:

- **Run 6—Question 1:** *What does the message on the sign located on TWY E3 tell you? Was it easy to interpret? What do you think of the message on the sign?*

Twelve subject pilots indicated the message on the sign located on TWY E3 advised them of construction on the ramp. Five pilots reported not seeing the sign. Seven pilots reported that the sign was easy to interpret. Eight pilots indicated the sign had a clear or good message.

- **Run 6—Question 2:** *Did you notice the sign prior to stopping? Does the location of the sign need improvement? If so, how?*

Eleven pilots indicated that they noticed the sign prior to stopping. Five pilots indicated that they did not see the sign prior to stopping. As for the location of the sign, ten pilots agreed that the location did not need improvement. Three pilots stated that the location needed improvement. Other comments suggested that the signs should be moved “to have a more noticeable location” and “thermoplastic signs” be used.

5.1.3.7 Results of Run 7.

In run 7, the visibility was clear and took place during daytime conditions. Pilots were told to taxi to Gate 23 from TWY B2. Once the pilots completed this run, they completed an evaluation. During this run, the pilots observed the CONSTRUCTION ON RAMP sign collocated with a sign array, as shown in figure 30.



Figure 30. Run 7 Simulated CONSTRUCTION ON RAMP Sign Collocated With Sign Array During Daytime Conditions

The pilots were asked:

- **Run 7—Question 1:** *Did you notice the sign prior to stopping? How does this location compare to the previous location of the sign?*

All 17 pilots indicated that they noticed the sign (shown in figure 31) prior to stopping. Seven pilots indicated they preferred this location, and seven pilots indicated they did not like this sign collocated with the sign array. Several pilots who were in favor of the location indicated that they liked the sign closer to the other signs. Pilots who were not in favor of the sign collocated with a sign array commented that it was “too busy” and “blends in/harder to see.”



Figure 31. Run 7 Simulated CONSTRUCTION ON RAMP Sign Collocated With Sign Array During Daytime Conditions

5.2 LEGEND HEIGHT AND COLOR EVALUATION.

During the second evaluation, which took place following the sign evaluations at the AFTIL, an FAA Airport Safety R&D team provided input as to whether black or white character legends were visible and pronounced against the safety orange retroreflective sheeting during day and night conditions.

5.2.1 Overview.

Upon completing the evaluations at the AFTIL, the researchers determined that further testing was needed regarding the character color. This was deemed necessary since the outside elements would show the true color of the character legend against the orange background.

On August 12, 2013, ten researchers evaluated 8-in. and 9-in., white and black character legends on an orange background. Evaluations occurred during daytime conditions, as shown in figure 32, as well as night. The legend heights were the same as those simulated on the signs during the AFTIL evaluations.



Figure 32. Daytime Tests at the William J. Hughes Technical Center—With Black and White 8-in. and 9-in. Character Legends

The test subjects started 700 feet from the sign while evaluating the character legend colors. The researchers viewed the sign in sections, with the top line of characters being one section, and the bottom line being another section. The top line had 8-in. white and black character legends, and the bottom line had 9-in. white and black character legends. After viewing each line, each researcher completed an evaluation, provided in appendix E.

5.2.2 Results.

After evaluating each character color (black and white), in two different heights on the sign, researchers provided their comments on an evaluation form, provided in appendix E.

First, it was determined whether the safety orange-colored sign was visible at a distance of 700 feet. Then, the researchers evaluated the top line, with a character legend height of 8 inches. The majority of the researchers commented that the sign became conspicuous at 450 feet, but it became readable between 300 and 400 feet for both the black and white characters.

Next, the researchers evaluated the bottom line, which had a character legend height of 9 inches. The researchers indicated that the safety orange-colored sign was conspicuous at a distance of 700 feet. The majority of the researchers commented that the sign became readable between 400 and 500 feet for both the black and white characters.

After the researchers evaluated the 8- and 9-inch white and black character legends, they were asked which color they preferred against the orange background. The researchers preferred the black character legends stating they were easier to see, and the contrast was better compared to the white character legends.

Researchers also evaluated the orange sign during nighttime conditions. Upon viewing each line of characters, each researcher completed an evaluation, provided in appendix E. First, the researchers indicated that the safety orange-colored sign was visible at a distance of 700 feet. Then, the researchers evaluated the top line of the sign with the 8-inch character legend height. The majority of the researchers commented that the sign became conspicuous at 400 feet, but it became readable between 200 and 350 feet for both the black and white characters.

Next, the researchers evaluated the bottom line of the sign with the 9-inch character legend height. The researchers indicated that the safety orange-colored sign was conspicuous at a distance of 700 feet. The majority of the researchers commented that the sign became readable between 200 and 350 feet for both the black and white characters.

After the researchers evaluated the 8- and 9-inch white and black character legends, as shown in figure 33, they were asked which color they preferred against the safety orange background. The researchers commented that the white characters blended in with the orange background, and that the white character legends washed out against the background. The researchers noted that the black character legends stood out against the orange background, and they were able to clearly read and understand the message. In addition, the researchers collaborated and concluded that black lettering on orange background, similar to roadway construction signs, are visible during daytime and nighttime conditions. It was determined that these results differed from the AFTIL results because the testing occurred outside (i.e., among environmental elements) that vehicle operators and pilots would more likely be exposed to while on the airfield.



Figure 33. Nighttime Tests at the William J. Hughes Technical Center—With Black and White 8-in. and 9-in. Character Legends

6. FINAL SIGN DESIGNS.

This section describes the legend and fabrication methods of the signs developed for the airport phase of evaluations. Each sign consisted of aluminum panels covered in the front with safety orange retroreflective tape with legend characters and borders composed of black vinyl tape. The tape used for the construction signs was 3M Diamond Grade 4084 Fluorescent Orange, which was in accordance with ASTM Type XI specifications.

6.1 LEGEND TEXT.

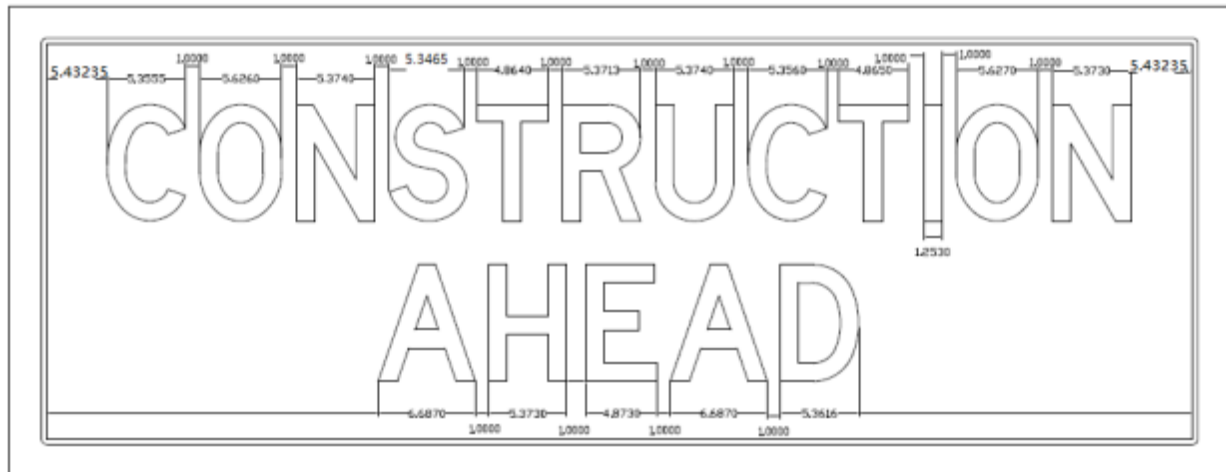
Based on the AFTIL and outdoor evaluations conducted at the William J. Hughes Technical Center, the research team selected three signs for further evaluation during the airport phase of testing.

- CONSTRUCTION AHEAD
- CONSTRUCTION ON RAMP
- RWY XX TORA XXXX FT

Because the initial results indicated that a significant proportion of pilots did not understand the TORA acronym, a fourth sign was tested that spelled out the words of this acronym. This sign read, TAKEOFF RUN AVAILABLE, and was tested in place of the TORA sign during the airport evaluation phase.

6.1.1 Construction Ahead.

The first sign, shown in figure 34, was the CONSTRUCTION AHEAD sign. It featured 8-in.-high legend text on a 30- by 84.15-in. panel. The borders for all tested signs were 0.875-in. black stripes with 0.375-in. outside margins



Character Height: 8"
Character Gap: 1"
Space Between Lines: 3.4"
Panel Size: 30" x 84.15"
Black Border: 0.875"
Outside Margin: 0.375"

Figure 34. CONSTRUCTION AHEAD Sign Legend

6.1.2 Construction on Ramp.

As shown in figure 35, the legend text of the CONSTRUCTION ON RAMP sign was similar to the CONSTRUCTION AHEAD SIGN, with 8 in. legend text height on the same sized metal panel (30 by 84.15 in.). The words ON and RAMP were separated by 4 in.

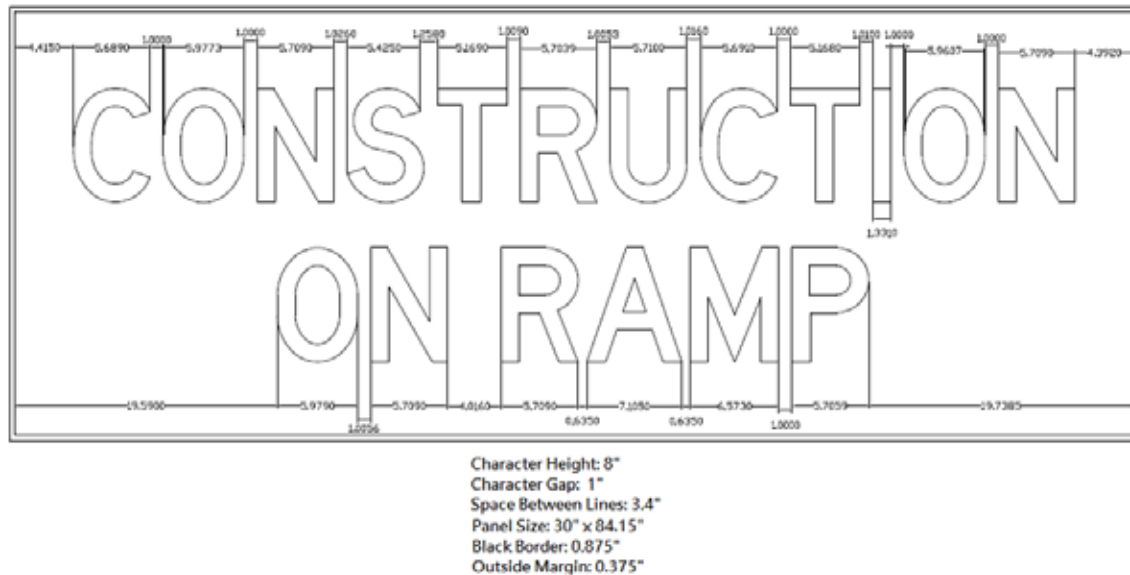
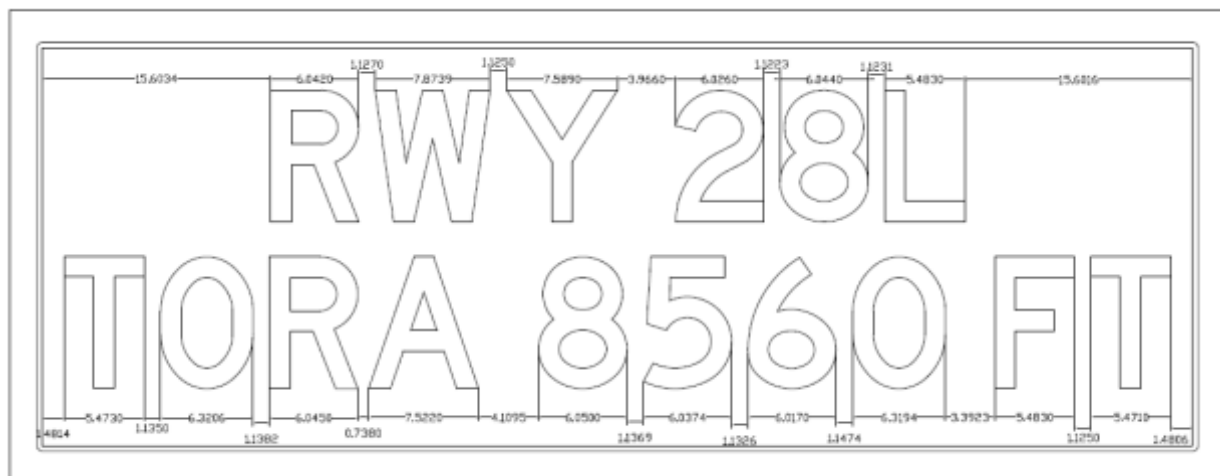


Figure 35. CONSTRUCTION ON RAMP Sign Legend

6.1.3 Takeoff Run Available.

The TORA signage evaluated at PDX featured larger, 9-in. text height due to having fewer legend characters. As shown in figure 36, the sign featured the runway designation on the top line of legend text (RWY XXX), and the bottom line featured the abbreviation TORA and the distance value (XXXX FT). The sign panel size is 30 by 84.15 in.

Figure 37 depicts a variation of this TORA signage evaluated at JFK with the TORA acronym spelled out. Due to the additional characters, the size of the legend text was reduced to 8 in., and the overall length of the sign was increased from 84.15 to 120 in. to contain the entire legend message. The outside margins of the legend text rows were a fixed size, allowing the runway and distance values to be changed without altering the other text.



Character Height: 9"
 Character Gap: 1"
 Word Spacing: 4"
 Space Between Lines: 2.4"
 Panel Size: 30" x 84.15"
 Black Border: 0.875"
 Outside Margin: 0.375"

Figure 36. The TORA Sign Legend Evaluated at PDX



Character Height: 8"
 Character Gap: 1"
 Space Between Lines: 3.4"
 Black Border: 0.875"
 Outside Margin: 0.375"

Figure 37. The TAKEOFF RUN AVAILABLE Sign Legend Evaluated at JFK

6.2 SIGN FABRICATION.

The signs were fabricated in accordance with AC 150/5345-44 [4], paragraph 3.2.6.4, “Unlighted Sign Mounting Legs.” Support legs were mounted to the back of the sign to avoid obstruction to any portion of the sign front. The signs were fabricated using three base stands. Each base stand featured a threaded mount bolted to its center to receive a frangible coupling, as shown in figure 38. The frangible couplings complied with AC 150/5345-44 [4] and were rated by the manufacturer to withstand wind speeds and jet blast of 100 miles per hour. It is assumed that sign manufacturers conduct independent frangibility tests to ensure they meet or exceed the existing frangibility requirements in AC 150/5345-44. A frangibility test of the signs was conducted with the FAA Boeing 727 aircraft to determine the sign’s ability to withstand jet blast and wind of this speed. The sign was undamaged by this test, but the researchers were unable to confirm the precise speed of the wind due to limits in the instrumentation used. It should be noted that throughout the airport evaluation phase of this project, no signs were damaged by wind or jet blast at any of the six airports at which these signs were installed. Design features of the signs, including tether cables and heavily-weighted, lower-profile bases, are designed to prevent damage in the rare event that the signs do become disengaged from their frangible couplings.



Figure 38. Base Stand and Frangible Coupling

As shown in figure 39, tether cables were affixed from the sign base stands to the detachable portion of the frangible couplings.



Figure 39. Frangible Coupling Tether

The sign panels were secured to the support legs via u-bolts, with 1/2-in. nuts and washers, as shown in figure 40.



Figure 40. Attachment of Legs to Sign Panel

Sign supports were secured by four, low-profile, weighted construction barriers. Each barrier was weighted down by a minimum of 150 lb of water (600 lb total weight). These barriers were filled either before or after assembling the signs, depending on the installation requirements at the airports. These barriers were distributed equally across the signs so each base leg was adequately covered, as shown in figure 41.



Figure 41. Weighted Barrier Positions

Each pair of barriers was tethered to the support bases via cables to ensure they would not become dislodged, as shown in figure 42.



Figure 42. Tethers on Weighted Barriers

In accordance with AC 150/5345-44 [4], the rear of the sign was painted with a primer coat and a low-luster, flat, black finish coat. All sharp edges on the signs were removed via cutting and sanding, so the surfaces were free from runs, blotches, and scratches.

7. AIRPORT EVALUATIONS.

From the evaluations at the AFTIL and the William J. Hughes Technical Center, the researchers determined the most appropriate message and color character legend regarding the safety orange construction signs. The purpose of the airport evaluations was to validate the effectiveness of the safety orange signs as to whether the addition of the signs increased the pilots' and vehicle operators' awareness of construction on the airfield. In addition to the visual aids currently being used by the airport operators, researchers at ISP, PVD, ORD, PDX, SFB, and JFK installed one or more of the following safety orange construction signs: CONSTRUCTION AHEAD and/or

CONSTRUCTION ON RAMP. Prior to sign installation, researchers provided each airport operator with a test plan, which entailed the evaluation approach. Prior to receiving the test plan, researchers worked with the airport operators to determine sign locations.

Researchers contacted the Air Line Pilots Association (ALPA) to have the evaluation disseminated to their members. ALPA's Airport Ground Environment (AGE) Group posted the evaluation within the October 2013 edition of "FASTRead," [5] a monthly safety update newsletter that is sent to 53,000 members. The article included an introduction identifying the project objectives and the hyperlink to the pilot questionnaire. By having the hyperlink to the pilot questionnaire available in ALPA's "FASTRead," many people in the pilot community were made aware of the questionnaire. In addition, airline station managers, chief pilots, and managers for the fixed-based operators from the airports and researchers distributed the questionnaires for the pilots to complete. The airport operator from each airport distributed the questionnaires to their airfield drivers.

The purpose of the evaluation was for airport vehicle operators and pilots to determine the effectiveness of the safety orange construction signs to notify them of existing construction on an airfield.

7.1 LONG ISLAND MacARTHUR AIRPORT.

7.1.1 Installation.

Two safety orange CONSTRUCTION AHEAD signs, measuring 30 in. high by 84 in. wide, were installed at TWY S before the cutoff of TWY E and RWY 10, approaching west of RWY 33L, as shown in figure 43.

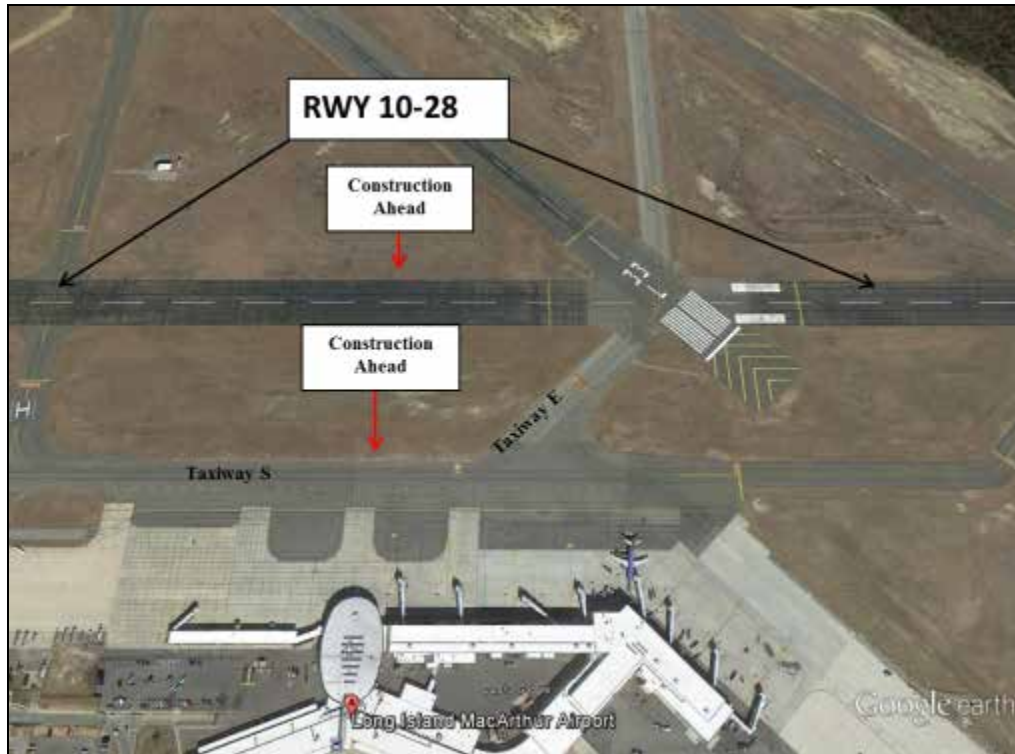


Figure 43. Overview of Safety Orange Construction Sign Locations at ISP

Researchers installed the CONSTRUCTION AHEAD sign on TWY S between the terminal direction sign (#77 on the marking and signage plan) and the 33L directional sign (#111 on the marking and signage plan). The sign was installed 49.5 feet from the TERM directional sign and 35 feet from pavement edge, as shown in figure 44.



Figure 44. CONSTRUCTION AHEAD Sign From TWY S View at ISP

The second CONSTRUCTION AHEAD sign was located 226 feet from the edge of the pavement from TWY B and 35 feet in from the edge of the pavement from RWY 10, as shown in figure 45.



Figure 45. CONSTRUCTION AHEAD Sign as Observed on RWY 10 at ISP

7.1.2 Results.

The airport operator distributed the vehicle operator evaluation, provided in appendix G, to Airport Operations and Maintenance, Aircraft Rescue Fire and Fighting (ARFF) personnel, and other tenants with airfield driving privileges. The airport operator distributed the pilot evaluation hard copy, as shown in appendix G, several FBOs and flight schools including: New York Jet/Mid Island Air Service, Hawthorne Global Air Services, Heritage Flight Academy, and ATP Flight School. Researchers also distributed the pilot evaluations to the ISP station managers at U.S. Airways, Penair, and Southwest Airlines for distribution to their pilots. No pilot evaluations were completed for this airport. The evaluation period was from September 13 through October 11, 2013.

The vehicle operators had the opportunity to evaluate the following safety orange construction signs at the airport:

- CONSTRUCTION AHEAD sign on TWY S before the cutoff of TWY E
- CONSTRUCTION AHEAD sign on RWY 10 approaching west of RWY 33L

The vehicle operators who evaluated both CONSTRUCTION AHEAD signs during nighttime conditions did not provide comments. Several comments provided by the vehicle operators who completed the evaluation during daytime conditions included:

- “The signage clearly depicts that vehicle operators and pilots are approaching a construction area and that they should use caution.”
- “Very understandable/visible from a good distance.”
- “Sign color drew attention immediately upon entering airfield.”

Table 1 identifies the vehicle operator results of the CONSTRUCTION AHEAD sign on TWY S. Seventeen vehicle operators completed the evaluation.

Table 1. Vehicle Operator Results for ISP TWY S—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	17	0	0	0	29	71
Daytime	16	0	0	0	31	69
Nighttime	1	0	0	0	0	100
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	17	0	0	0	41	59
Daytime	16	0	0	0	44	56
Nighttime	1	0	0	0	0	100
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	17	0	0	6	29	65
Daytime	16	0	0	6	31	63
Nighttime	1	0	0	0	0	100

Table 2 identifies the vehicle operator results of the CONSTRUCTION AHEAD sign on RWY 10. Eighteen vehicle operators completed the evaluation.

Table 2. Vehicle Operator Results for ISP RWY 10—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	18	0	0	0	33	67
Daytime	17	0	0	0	35	65
Nighttime	1	0	0	0	0	100
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	18	0	0	0	44	56
Daytime	17	0	0	0	50	50
Nighttime	1	0	0	0	0	100
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	18	0	0	6	27	67
Daytime	17	0	0	6	29	65
Nighttime	1	0	0	0	0	100

7.2 THEODORE FRANCIS GREEN STATE AIRPORT.

7.2.1 Signage Installation.

One CONSTRUCTION AHEAD and one CONSTRUCTION ON RAMP sign, each measuring 30 in. high by 84 in. wide, were installed at PVD. The CONSTRUCTION AHEAD sign was installed at TWY T adjacent to the intersection with TWY N, while the CONSTRUCTION ON RAMP sign was installed at TWY A near the GA parking entrance, as shown in figure 46.



Figure 46. Overview of Safety Orange Construction Sign Locations at PVD

Researchers installed the CONSTRUCTION AHEAD sign on TWY T, 36 feet from the pavement edge, as shown in figure 47.



Figure 47. CONSTRUCTION AHEAD Sign on TWY T at PVD

After the installation of the sign on TWY T was completed, researchers installed the safety orange CONSTRUCTION ON RAMP sign on TWY A near the GA parking entrance. The sign was installed 125 feet from the non-movement line and 35 feet from the defined pavement edge.

After the two safety orange construction signs were installed, the Eastern Region Airport Certification and Safety Inspector determined that tie-down anchors would be more appropriate to secure the signs than low-profile barriers. The airport operator removed the CONSTRUCTION ON RAMP sign from TWY A, since there was no construction activity occurring due to scheduling issues with the contractor performing that work on the ramp. The airport operator indicated that once construction began, the CONSTRUCTION ON RAMP sign would be relocated to its original location with tie-down anchors.

Construction commenced on November 18, 2013 on the GA Parking Ramp. The airport operator reinstalled the safety orange CONSTRUCTION ON RAMP sign on TWY A near the entrance to GA Parking, 125 feet from the nonmovement line and 35 feet from the defined pavement edge, as shown in figure 48.



Figure 48. CONSTRUCTION ON RAMP Sign on TWY A at PVD

7.2.2 Evaluation Results.

The airport operator distributed the vehicle operator evaluations, provided in appendix H, to Airport Operations, Maintenance, ARFF, and other tenants who have airfield driving privileges. The airport operator distributed the pilot evaluation hard copy, provided in appendix H, to representatives at the airlines and FBOs. The evaluation period was originally from September 12 through October 28, 2013. The airport operator allowed the researchers to extend the evaluation date to January 6, 2014 to collect more data because the CONSTRUCTION ON RAMP sign was taken down during the evaluation period as construction was postponed.

The vehicle operators had the opportunity to evaluate the following safety orange construction signs at the airport:

- CONSTRUCTION AHEAD sign on TWY T adjacent to the intersection with TWY N
- CONSTRUCTION ON RAMP sign on TWY A near the GA parking entrance

A vehicle operator who evaluated both the CONSTRUCTION AHEAD and CONSTRUCTION ON RAMP signs during daytime conditions commented that they both “look good.”

Table 3 identifies the vehicle operator results of the CONSTRUCTION AHEAD sign on TWY T. Ten vehicle operators completed the evaluation.

Table 3. Vehicle Operator Results for PVD TWY T—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	10	0	0	0	40	60
Daytime	5	0	0	0	20	80
Nighttime	2	0	0	0	0	100
Time unknown	3	0	0	0	100	0
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	10	0	0	0	50	50
Daytime	5	0	0	0	40	60
Nighttime	2	0	0	0	0	100
Time unknown	3	0	0	0	100	0

Table 3. Vehicle Operator Results for PVD TWY T—CONSTRUCTION AHEAD Sign
(Continued)

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	10	0	0	0	40	60
Daytime	5	0	0	0	20	80
Nighttime	2	0	0	0	0	100
Time unknown	3	0	0	0	100	0

Table 4 identifies the vehicle operator results of the CONSTRUCTION ON RAMP sign on TWY A. Three vehicle operators completed the evaluation.

Table 4. Vehicle Operator Results for PVD TWY A—CONSTRUCTION ON RAMP Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	3	0	0	0	0	100
Daytime	1	0	0	0	0	100
Nighttime	2	0	0	0	0	100
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	3	0	0	0	0	100
Daytime	1	0	0	0	0	100
Nighttime	2	0	0	0	0	100
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	3	0	0	0	0	100
Daytime	1	0	0	0	0	100
Nighttime	2	0	0	0	0	100

Pilots had the opportunity to evaluate the following safety orange construction signs at the airport:

- CONSTRUCTION AHEAD sign on TWY T adjacent to the intersection with TWY N
- CONSTRUCTION ON RAMP sign on TWY A near the GA parking entrance area

A pilot who evaluated the CONSTRUCTION ON RAMP sign during daytime conditions commented that it was a “good idea.” Another pilot commented “can’t miss it.” The pilot who evaluated this sign during nighttime conditions indicated the “sign stands out clearly.” The pilot who evaluated the CONSTRUCTION AHEAD sign during daytime conditions made the comment “like the signage,” and stated that it was “very visible and attention getting.”

Table 5 identifies the pilot results of the CONSTRUCTION AHEAD sign on TWY T. Two pilots completed the evaluation.

Table 5. Pilot Results for PVD TWY T—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	2	0	0	0	50	50
Daytime	2	0	0	0	50	50
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	2	0	0	0	50	50
Daytime	2	0	0	0	50	50
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	2	0	0	0	50	50
Daytime	2	0	0	0	50	50

Table 6 identifies the pilot results of the CONSTRUCTION ON RAMP sign on TWY A. Ten pilots completed the evaluation.

Table 6. Pilot Results for PVD TWY A—CONSTRUCTION ON RAMP Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	10	10	0	10	20	60
Daytime	8	13	0	0	25	62
Nighttime	1	0	0	0	0	100
Time unknown	1	0	0	100	0	0
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	10	0	0	10	30	60
Daytime	8	0	0	0	25	75
Nighttime	1	0	0	0	100	0
Time unknown	1	0	0	100	0	0
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	10	0	0	10	40	50
Daytime	8	0	0	0	37	63
Nighttime	1	0	0	0	100	0
Time unknown	1	0	0	100	0	0

7.3 CHICAGO O'HARE INTERNATIONAL AIRPORT.

7.3.1 Signage Installation.

Two safety orange CONSTRUCTION AHEAD signs, each measuring 30 in. high by 84 in. wide, were installed at TWY C1, adjacent to intersection with TWY C and TWY Z, adjacent to the intersection with TWY C, as shown in figure 49.



Figure 49. Overview of Safety Orange Construction Sign Locations at ORD

The airport operator agreed to install the safety orange construction signs prior to the researchers arriving so the evaluation period could be extended. The airport operator installed the near side of the safety orange CONSTRUCTION AHEAD sign, which was installed on the east side of TWY C1 and was approximately 46 feet perpendicular to the taxiway edge marking of TWY C1, as shown in figure 50.



Figure 50. CONSTRUCTION AHEAD Sign on TWY C1 at ORD

The airport operator installed the CONSTRUCTION AHEAD sign on TWY Z, adjacent to the intersection with TWY C. The near side of the safety orange construction sign located on the east side of TWY Z, was approximately 43 feet perpendicular to the edge marking of TWY Z, as shown in figure 51. Researchers traveled to ORD and verified the two safety orange construction signs were properly installed.



Figure 51. CONSTRUCTION AHEAD Sign on TWY Z at ORD

7.3.2 Evaluation Results.

The airport operator distributed the vehicle operator evaluation, provided in appendix I, to Airport Operations, Airfield Electricians, the airport drivers' dispatch office, and other tenants who have airfield driving privileges. The airport operator distributed the pilot evaluation hard

copy, provided in appendix I, to chief pilots during a meeting. Researchers distributed the pilot evaluations, provided in appendix I, to the ORD chief pilots at Mesa Air, United Airlines, Delta Airlines, and American Airlines for distribution to their pilots. No pilot evaluations were completed for this airport. The evaluation period originally was from September 16 through October 11, 2013. The airport operator informed the researchers that the evaluation period was extended due to the punch list items for the construction project that would take a couple of weeks. The evaluation was extended to December 6, 2013 and the signs were removed afterwards.

The vehicle operators had the opportunity to evaluate the following safety orange construction signs at the airport:

- CONSTRUCTION AHEAD sign on TWY C1, adjacent to intersection with TWY C
- CONSTRUCTION AHEAD sign on TWY Z, adjacent to the intersection with TWY C

Table 7 identifies the vehicle operator results of the CONSTRUCTION AHEAD sign on TWY C1. Twelve vehicle operators completed the evaluation.

Table 7. Vehicle Operators Results for ORD TWY C1—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	12	0	25	25	50	0
Daytime	7	0	14	14	72	0
Nighttime	5	0	40	40	20	0
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	12	8	17	0	75	0
Daytime	7	14	14	0	72	0
Nighttime	5	0	20	0	80	0
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	12	8	0	17	75	0
Daytime	7	14	0	14	72	0
Nighttime	5	0	0	20	80	0

Table 8 identifies the vehicle operator results of the CONSTRUCTION AHEAD sign on TWY Z. Eight vehicle operators completed the evaluation.

Table 8. Vehicle Operator Results for ORD TWY Z—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	8	0	38	12	50	0
Daytime	5	0	20	20	60	0
Nighttime	2	0	100	0	0	0
Unknown time	1	0	0	0	100	0
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	8	12	25	0	63	0
Daytime	5	20	20	0	60	0
Nighttime	2	0	50	0	50	0
Unknown time	1	0	0	0	100	0
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	8	12	0	25	63	0
Daytime	5	20	0	20	60	0
Nighttime	2	0	0	50	50	0
Unknown time	1	0	0	0	100	0

7.4 PORTLAND INTERNATIONAL AIRPORT.

7.4.1 Signage Installation.

Three safety orange construction signs, each measuring 30 in. high by 84 in. wide with the following messages were installed: CONSTRUCTION AHEAD, CONSTRUCTION ON RAMP, and RWY 28L TORA 8560 FT. The locations of the installations were TWY C between TWY C5 and TWY C6 (CONSTRUCTION AHEAD) and TWY E5 north side of taxiway (CONSTRUCTION ON RAMP) and TWY C6 prior to the runway holding position (RWY 28L TORA 8560 FT), as shown in figure 52.



Figure 52. Overview of Safety Orange Construction Sign Locations at PDX

Researchers installed the CONSTRUCTION AHEAD sign west on TWY C between TWY C5 and TWY C6. This sign was located approximately 330 feet west of the TWY C location/C6 direction sign. The near side of the safety orange construction sign was approximately 51 feet 6 inches from the taxiway edge marking (pavement edge), as shown in figure 53. This is the same distance of the near side of the TWY C location/C6 directional sign from the taxiway edge marking (pavement edge).



Figure 53. CONSTRUCTION AHEAD Sign on TWY C at PDX

Next, the researchers installed the RWY 28L TORA 8560 FT on TWY C6 prior to the runway holding position. The near side of the sign was approximately 49 feet perpendicular from the taxiway edge marking (pavement edge), as shown in figure 54. In addition, this sign was installed approximately 52 feet laterally from the runway 10R-28L mandatory hold sign.



Figure 54. The RWY 28L TORA 8560 FT Sign at PDX

The researchers installed the CONSTRUCTION ON RAMP sign on TWY E5 north side of the taxiway. The near side of the sign was 35 feet 6 inches perpendicular to the TWY E5 edge marking (pavement edge). In addition, the researchers canted the sign towards TWY E, so pilots could see the sign prior to turning on TWY E5 and to the ramp area, as shown in figure 55.



Figure 55. CONSTRUCTION ON RAMP Sign at PDX

7.4.2 Evaluation Results.

The airport operator distributed the vehicle operator evaluation, provided in appendix J, to Airport Operations, Maintenance, and other tenants who have airfield driving privileges. The airport operator distributed the pilot evaluation hard copy, also provided in appendix J, to chief pilots for distribution to their pilots. The evaluation period was from September 24 through October 25, 2013.

The vehicle operators had the opportunity to evaluate the following safety orange construction signs at the airport:

- CONSTRUCTION AHEAD sign on TWY C between TWY C5 and TWY C6
- CONSTRUCTION ON RAMP on TWY E5 north side of taxiway

Several vehicle operators who evaluated the two signs at the airport commented:

- “Very visible in darkness, great new tool.”
- “They do stand out as the color is not seen on the airfield.”

- “Signs are visible when passing by. Flashing beacon on top of signs could be helpful.”
- “Since they’re obviously unlighted, it’s dependent on taxi lights or headlights to activate the reflective qualities. Would a small flashing beacon help to draw attention to sign?”

Table 9 identifies the vehicle operator results of the CONSTRUCTION AHEAD sign on TWY C. A total of 12 vehicle operators completed the evaluation.

Table 9. Vehicle Operator Results for PDX TWY C—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	12	0	8	0	50	42
Daytime	6	0	0	0	50	50
Nighttime	4	0	25	0	25	50
Time unknown	2	0	0	0	100	0
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	12	0	8	17	42	33
Daytime	6	0	0	0	50	50
Nighttime	4	0	25	25	25	25
Time unknown	2	0	0	50	50	0
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	12	0	8	0	50	42
Daytime	6	0	0	0	33	67
Nighttime	4	0	25	0	50	25
Time unknown	2	0	0	0	100	0

7.4.2.1 Vehicle Operator Results for PDX TWY E5—CONSTRUCTION ON RAMP.

Table 10 identifies the vehicle operator results of the CONSTRUCTION ON RAMP sign on TWY E5. Twelve vehicle operators completed the evaluation.

Table 10. Vehicle Operator Results for PDX TWY E5—CONSTRUCTION ON RAMP Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	12	8	0	0	50	42
Daytime	6	0	0	0	50	50
Nighttime	4	25	0	0	25	50
Time unknown	2	0	0	0	100	0
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	12	8	0	17	42	33
Daytime	6	0	0	0	50	50
Nighttime	4	25	0	25	25	25
Time unknown	2	0	0	50	50	0
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	12	8	0	0	50	42
Daytime	6	0	0	0	33	67
Nighttime	4	25	0	0	50	25
Time unknown	2	0	0	0	100	0

Table 11 identifies the vehicle operator results of the RWY 28L TORA 8560 FT sign on TWY C6. Eleven vehicle operators completed the evaluation.

Table 11. Vehicle Operator Results for PDX TWY C6—RWY 28L TORA 8560 FT Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	11	0	10	0	45	45
Daytime	5	0	0	0	40	60
Nighttime	4	0	25	0	50	25
Time unknown	2	0	0	0	50	50
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	11	0	10	18	45	27
Daytime	5	0	0	0	60	40
Nighttime	4	0	25	25	25	25
Time unknown	2	0	0	50	50	0
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	11	10	0	0	54	36
Daytime	5	0	0	0	40	60
Nighttime	4	25	0	0	50	25
Time unknown	2	0	0	0	100	0

7.4.2.2 Pilot Evaluations Results.

The pilots had the opportunity to evaluate the following safety orange construction signs at the airport:

- CONSTRUCTION AHEAD sign on TWY C between TWY C5 and TWY C6
- CONSTRUCTION ON RAMP on TWY E5 north side of taxiway

A pilot who evaluated the CONSTRUCTION AHEAD sign commented, "...if the sign wasn't obvious enough, the barricaded taxiway certainly was."

Three pilots who evaluated either the CONSTRUCTION AHEAD or CONSTRUCTION ON RAMP signs suggested the following:

- “Need lights on sign at night.”
- “Need lighted signs or lights near signs at night.”
- “Lighted sign at night would be helpful.”

7.4.2.2.1 Pilot Results for PDX TWY C—CONSTRUCTION AHEAD Sign.

Table 12 identifies the pilot results of the CONSTRUCTION AHEAD sign on TWY C. Six vehicle operators completed the evaluation.

Table 12. Pilot Results for PDX TWY C—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	6	17	0	0	33	50
Daytime	3	33	0	0	0	67
Nighttime	3	0	0	0	67	33
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	6	17	0	0	33	50
Daytime	3	33	0	0	0	67
Nighttime	3	0	0	0	67	33
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	6	17	0	0	33	50
Daytime	3	33	0	0	0	67
Nighttime	3	0	0	0	67	33

7.4.2.2.2 Pilot Results for PDX TWY E5—Construction on Ramp.

Table 13 identifies the pilot results of the CONSTRUCTION ON RAMP sign on TWY E5. Five pilots completed the evaluation.

Table 13. Pilot Results for PDX TWY E5—CONSTRUCTION ON RAMP Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	5	0	0	20	0	80
Daytime	2	0	0	0	0	100
Nighttime	3	0	0	33	0	67
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	5	0	0	20	0	80
Daytime	2	0	0	0	0	100
Nighttime	3	0	0	33	0	67
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	5	0	0	20	0	80
Daytime	2	0	0	0	0	100
Nighttime	3	0	0	33	0	67

7.5 ORLANDO SANFORD INTERNATIONAL AIRPORT.

7.5.1 Signage Installation.

Two safety orange construction signs, CONSTRUCTION AHEAD and CONSTRUCTION ON RAMP, each measuring 30 inches high by 84 inches wide were installed. The signs were installed on the north side on the terminal apron approximately 433 feet from terminal (CONSTRUCTION AHEAD), and south side on the terminal apron approximately 696 feet west of the Customs and Border Patrol Apron (CONSTRUCTION ON RAMP), as shown in figure 56. The distance between the two signs was 657 feet.



Figure 56. Overview of Safety Orange Construction Sign Locations at SFB

The airport operator agreed to install the safety orange construction signs. The airport operator installed the safety orange CONSTRUCTION AHEAD sign, on the terminal apron north side of the construction project, as shown in figure 57.



Figure 57. CONSTRUCTION AHEAD Sign on North Side of the Terminal Apron at SFB

The airport operator installed the CONSTRUCTION ON RAMP on the south side of the construction area on the terminal apron, as shown in figure 58.



Figure 58. CONSTRUCTION ON RAMP Sign on the South Side of the Terminal Apron at SFB

7.5.2 Evaluation Results.

The airport operator distributed the vehicle operator evaluation, provided in appendix K, to Airport Operations, Maintenance, ARFF, and ground handlers. The airport operator distributed the pilot evaluation hard copy, also provided in appendix K, to representatives at the airlines and FBOs. The airport operator also informed this group about the electronic evaluation. The evaluation period was from December 3, 2013 through January 6, 2014.

The vehicle operators had the opportunity to evaluate the following safety orange construction signs at the airport:

- CONSTRUCTION AHEAD sign on the terminal apron south side
- CONSTRUCTION ON RAMP sign on the terminal apron north side

A vehicle operator who evaluated both safety orange construction signs stated, “I drive on the terminal apron daily and have no issues observing the safety signs from a distance for both north and south sides.” Another vehicle operator who evaluated the CONSTRUCTION ON RAMP sign commented that the sign was “helpful in delineating the actual construction area.” Three vehicle operators commented that the safety orange construction signs should have some type of lighting during night time conditions.

Table 14 identifies the vehicle operator results of the CONSTRUCTION AHEAD sign on terminal apron south side. Sixteen vehicle operators completed the evaluation.

Table 14. Vehicle Operator Results for the SFB South Side—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	16	0	0	0	69	31
Daytime	14	0	0	0	79	21
Nighttime	1	0	0	0	0	100
Time unknown	1	0	0	0	0	100
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	16	0	0	6	69	25
Daytime	14	0	0	7	79	14
Nighttime	1	0	0	0	0	100
Time unknown	1	0	0	0	0	100

Table 14. Vehicle Operator Results for the SFB South Side—CONSTRUCTION AHEAD Sign
(Continued)

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	16	0	0	0	62	38
Daytime	14	0	0	0	71	29
Nighttime	1	0	0	0	0	100
Time unknown	1	0	0	0	0	100

Table 15 identifies the vehicle operator results of the CONSTRUCTION ON RAMP sign on terminal apron north side. Eighteen vehicle operators completed the evaluation.

Table 15. Vehicle Operator Results for the SFB North Side—CONSTRUCTION ON RAMP
Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	18	0	0	0	67	33
Daytime	15	0	0	0	80	20
Nighttime	2	0	0	0	0	100
Time unknown	1	0	0	0	0	100
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	18	0	0	6	72	22
Daytime	15	0	0	7	80	13
Nighttime	2	0	0	0	50	50
Time unknown	1	0	0	0	0	100

Table 15. Vehicle Operator Results for the SFB North Side—CONSTRUCTION ON RAMP Sign (Continued)

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	18	0	0	0	61	39
Daytime	15	0	0	0	73	27
Nighttime	2	0	0	0	0	100
Time unknown	1	0	0	0	0	100

The pilots had the opportunity to evaluate the following safety orange construction signs at the airport:

- CONSTRUCTION AHEAD sign on the terminal apron south side
- CONSTRUCTION ON RAMP sign on the terminal apron north side

No evaluations were completed for the CONSTRUCTION AHEAD sign located on the terminal apron south side.

Table 16 identifies the pilot results of the CONSTRUCTION ON RAMP sign on terminal apron north side. Three pilots completed the evaluation.

Table 16. Pilot Evaluation Results for the SFB North Side—CONSTRUCTION ON RAMP Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	3	0	0	0	67	33
Daytime	3	0	0	0	67	33
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	3	0	0	0	67	33
Daytime	3	0	0	0	67	33

Table 16. Pilot Evaluation Results for the SFB North Side—CONSTRUCTION ON RAMP Sign (Continued)

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	3	0	0	0	67	33
Daytime	3	0	0	0	67	33

7.6 JOHN F. KENNEDY INTERNATIONAL AIRPORT.

7.6.1 Signage Installation.

Two types of safety orange construction signs were installed at JFK. The first was the 30 in. high by 84 in. wide CONSTRUCTION AHEAD sign. The other was the 30 in. high by 120 in. wide TAKEOFF RUN AVAILABLE sign. The locations of the installations varied due to multiple stages of construction take place. Examples of the positions the signs were positioned during the study are shown below in figure 59. These were generally in the vicinity of RWY 22R-4L. The complete list of the scheduled sign locations is shown in figure 60.

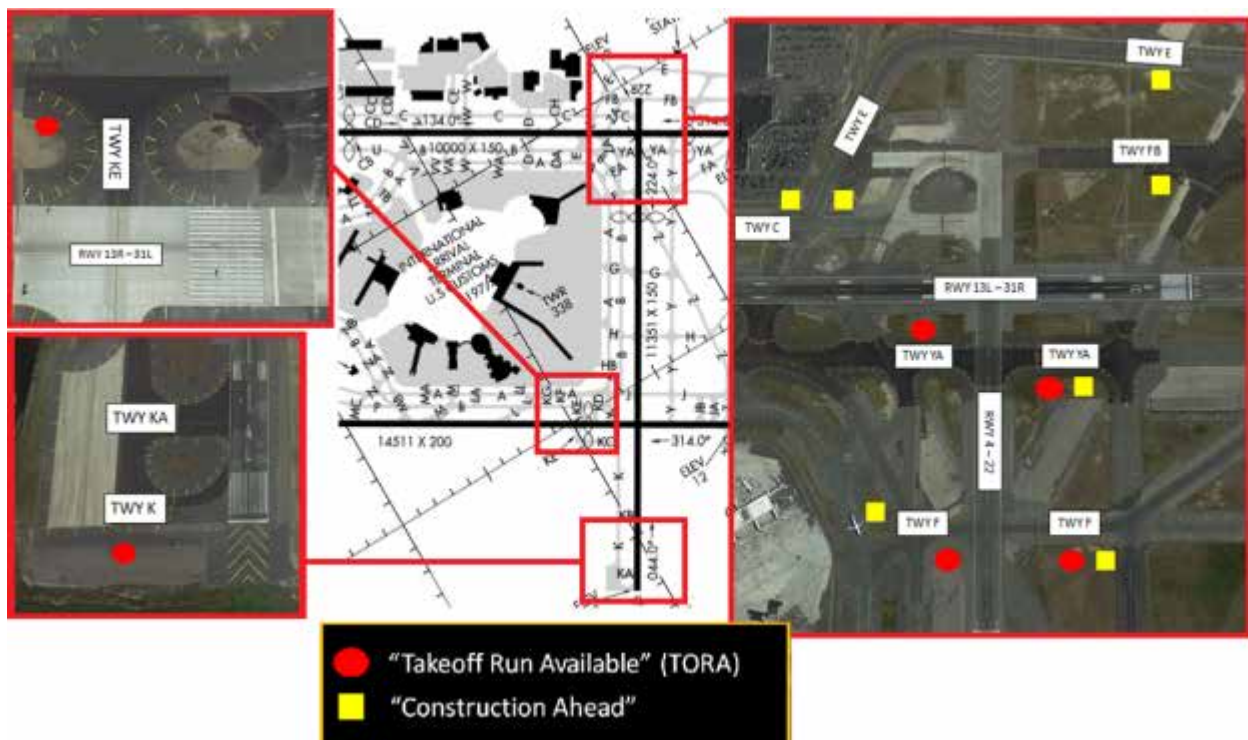


Figure 59. Sign Locations at JFK

JFK Runway 4L-22R Improvements Project										By: FAA-ARP-NYADO-SK						
Use of Temporary Safety Orange Construction Signs as a Test										Ver. 1.2 (Rev. 8/27/2014)						
SIGN SCHEDULE																
										Stage Sign is Needed						
										Sign Location Coordinates (NAD83)						
SIGN NO.	SIGN ID NO.	SIGN BASE NEEDED	SIGN TYPE	SIGN LEGEND	SIGN SIZE	SIGN LOCATION	1	1D	Comp	2	3	3G	Location Adjacent to Sign No.	NOTES	Latitude	Longitude
1	TS-01-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY E @ RWY 22R (EAST)	X	X	X	X	X	X	None		40°38'54.61"N	73°45'37.74"W
2	TS-02-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY FB @ RWY 22R (EAST)	X	X	X	X	X	X	None		40°38'48.87"N	73°45'42.08"W
3	TS-03-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY YA @ RWY 22R (EAST)	X	X	X	X	X	X	None		40°38'41.18"N	73°45'54.90"W
4	TS-04-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY F @ RWY 22R (EAST)		X			X	X	None		40°38'33.19"N	73°46'00.80"W
5	TS-05-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY G @ RWY 22R (EAST)					X	X	None		40°38'17.13"N	73°46'13.64"W
6	TS-06-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY H @ RWY 22R (EAST)					X	X	None		40°38'04.95"N	73°46'23.21"W
7	TS-07-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY I @ RWY 22R (EAST)					X	X	None		40°37'53.55"N	73°46'31.57"W
8	TS-08-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY E @ TWY C	X	X	X	X	X	X	None		40°38'58.93"N	73°46'08.11"W
9	TS-09-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY ZA @ TWY ZA	X	X	X	X	X	X	None		40°38'57.53"N	73°46'04.42"W
10	TS-10-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY F @ TWY B		X			X	X	None		40°38'40.66"N	73°46'13.75"W
11	TS-11-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY G @ TWY B					X	X	None		40°38'26.49"N	73°46'23.81"W
12	TS-12-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY H @ TWY B					X	X	None		40°38'14.37"N	73°46'33.18"W
13	TS-13-CA	1	CA	CONSTRUCTION AHEAD	TBD	TWY I @ RWY 22R (WEST)					X	X	None		40°38'00.38"N	73°46'40.43"W
14	TS-01-TORA	1	TORA	RWY 22R TORA 10,130 FEET	TBD	TWY YA @ RWY 22R (WEST)	X		X				None	1	40°38'48.57"N	73°46'04.78"W
15	TS-02-TORA	1	TORA	RWY 22R TORA 10,130 FEET	TBD	TWY YA @ RWY 22R (EAST)	X		X				None	1	40°38'42.30"N	73°45'57.24"W
16	TS-03-TORA	1	TORA	RWY 22R TORA 9,187 FEET	TBD	TWY F @ RWY 22R (WEST)		X			X		226	1	40°38'37.26"N	73°46'11.39"W
17	TS-04-TORA	1	TORA	RWY 22R TORA 9,187 FEET	TBD	TWY F @ RWY 22R (EAST)		X			X		None	1	40°38'34.07"N	73°46'02.72"W
18.A	TS-05-TORA	1	TORA	RWY 4L TORA 10,180 FEET	TBD	TWY K @ RWY 4L		X					None	2	40°37'21.04"N	73°47'13.59"W
18.B	TS-06-TORA	0	TORA	RWY 4L TORA 9,780 FEET	TBD	TWY K @ RWY 4L		X	X				None	2	40°37'21.04"N	73°47'13.59"W
18.C	TS-07-TORA	0	TORA	RWY 4L TORA 9,225 FEET	TBD	TWY K @ RWY 4L					X		None	2	40°37'21.04"N	73°47'13.59"W
21	TS-08-TORA	1	TORA	RWY 31L TORA 10,925 FEET	TBD	TWY KE @ RWY 31L					X	X	1508	1.3	40°38'02.16"N	73°46'58.60"W
21	TOTAL	19														
Batch 1 (Needed By 8/1/2014):													(8 Signs Total)			
Batch 2 (Needed By 9/15/2014):													(6 Signs Total)			
Batch 3 (Needed By 4/10/2015):													(7 Signs Total)			
NOTES:													(21 Signs/19 Bases Total)			
1) Note sign legend change (Revised TORA value) since previous version.																
2) One sign with modular sign insert to display applicable TORA value.																
3) All departures on shortened RWY 31L to be from TWY KE for both Stages 3 and 3G. Previous TORA Sign for "K" Departures Deleted.																
4) Sign locations may be adjusted in the field.																
Current Target Staging Schedule:																
Stage 1: 8/1/14 - 12/9/14						XXXXXXXXXX						Changed Since Previous Version				
Stage 1D: 9/15/14 - 9/28/14																
Stage 1 Completed: 12/10/14 - 2/28/15 (Winter 2014-2015)																
Stage 2: 3/1/15 - 4/9/15																
Stage 3: 4/10/15 - 9/21/15																
Stage 3G: 8/8/15 - 8/28/15																

Figure 60. Sign Schedule at JFK

Figure 61 depicts an example of the CONSTRUCTION AHEAD sign tested and figures 62 and 63 depict examples of the TAKEOFF RUN AVAILABLE sign. The TAKEOFF RUN AVAILABLE sign allows the TORA distance to be covered up with a metal insert showing a new value when needed. This took place at JFK during later phases of runway construction.



Figure 61. CONSTRUCTION AHEAD Sign at JFK



Figure 62. TAKEOFF RUN AVAILABLE Sign on TWY YA at JFK



Figure 63. TAKEOFF RUN AVAILABLE Sign at RWY 4L Entrance at JFK

7.6.2 Evaluation Results.

The researchers distributed the survey, provided in appendix L, to vehicle operators and pilots at JFK. The survey questions were the same as those used at the other airports. Sixteen individuals (10 pilots and 6 vehicle operators) reported observing the TAKEOFF RUN AVAILABLE sign, and 22 individuals (17 pilots and 5 vehicle operators) reported observing the CONSTRUCTION AHEAD sign.

As indicated in tables 17 through 20, pilots and vehicle operators were overwhelmingly favorable towards the signs. Most of the pilots reported the signs as conspicuous, comprehensible, and providing adequate notification of existing construction. Some vehicle operators mentioned that although the signs were adequate for their own use, they would not be large enough to be visible for pilots, as detailed in the following comments:

- “I am in a ground vehicle when viewing these signs. I don’t think they are very conspicuous for pilots of most of the aircraft using JFK.”
- “From a vehicle standpoint, the signs are visible. But I believe it would help if they were mounted a bit higher off the ground, similar to normal taxiway/runway signs.”

However, comments collected from pilots who responded to the survey did not express this concern:

- “The pilot saw the signs and knew closer attention would be necessary. Immediately obvious construction was underway.”

- “Feel these signs add to situational awareness.”
- “It’s nice having the info placed out on the airfield. The orange signage helps a ton.”

Table 17. Pilot Results for JFK—TAKEOFF RUN AVAILABLE Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	10	0	10	0	70	20
Daytime	2	0	50	0	50	0
Nighttime	1	0	0	0	100	0
Time unknown	7	0	0	0	71	29
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	10	0	0	10	80	10
Daytime	2	0	0	0	100	0
Nighttime	1	0	0	100	0	0
Time unknown	7	0	0	0	86	14
Statement 3: The sign adequately notified me of the distance available for takeoff.						
All conditions	10	0	10	10	50	30
Daytime	2	0	0	50	0	50
Nighttime	1	0	0	0	100	0
Time unknown	7	0	14	0	57	29

Table 18. Vehicle Operator Results for JFK—TAKEOFF RUN AVAILABLE Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	6	0	0	0	67	33
Daytime	2	0	0	0	50	50
Nighttime	0	0	0	0	0	0
Time unknown	4	0	0	0	75	25
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	6	0	0	17	50	33
Daytime	2	0	0	0	50	50
Nighttime	0	0	0	0	0	0
Time unknown	4	0	0	25	50	25
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	6	0	0	0	67	33
Daytime	2	0	0	0	50	50
Nighttime	0	0	0	0	0	0
Time unknown	4	0	0	0	75	25

Table 19. Pilot Results for JFK—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	17	0	6	6	65	24
Daytime	4	0	0	0	100	0
Nighttime	1	0	0	0	100	0
Time unknown	12	0	8	8	50	33
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	17	0	0	18	65	18
Daytime	4	0	0	50	50	0
Nighttime	1	0	0	100	0	0
Time unknown	12	0	0	0	75	25
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	17	0	0	6	65	29
Daytime	4	0	0	0	100	0
Nighttime	1	0	0	100	0	0
Time unknown	12	0	0	0	58	42

Table 20. Vehicle Operator Results for JFK—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	5	0	0	20	60	20
Daytime	1	0	0	100	0	0
Nighttime	0	0	0	0	0	0
Time unknown	4	0	0	0	75	25
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	5	0	0	20	60	20
Daytime	1	0	0	100	0	0
Nighttime	0	0	0	0	0	0
Time unknown	4	0	0	0	75	25
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	5	0	0	40	40	20
Daytime	1	0	0	100	0	0
Nighttime	0	0	0	0	0	0
Time unknown	4	0	0	0	75	25

7.7 SUMMARY—AIRPORT EVALUATIONS.

This section contains the combined results for the safety orange CONSTRUCTION AHEAD and CONSTRUCTION ON RAMP signs installed at all six airports and TAKEOFF RUN AVAILABLE signs installed at JFK.

Table 21 identifies the combined vehicle operator results of the CONSTRUCTION AHEAD sign at all six airports. Ninety-eight vehicle operators completed the evaluation.

Table 21. Combined Vehicle Operator Results—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	98	0	8	5	46	42
Daytime	71	0	3	4	48	44
Nighttime	16	13	18	13	13	43
Time unknown	11	0	0	9	46	45
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	98	2	5	4	54	35
Daytime	71	3	3	2	55	36
Nighttime	16	0	18	6	38	38
Time unknown	11	0	0	9	73	18
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	98	2	1	9	47	42
Daytime	71	3	0	7	43	46
Nighttime	16	0	7	13	43	37
Time unknown	11	0	0	0	82	18

Table 22 identifies the combined results from the PVD, PDX, and SFB vehicle operators who evaluated the CONSTRUCTION ON RAMP sign. Thirty-three vehicle operators completed the evaluation for this sign.

Table 22. Combined Vehicle Operator Results—CONSTRUCTION ON RAMP Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	33	3	0	0	55	42
Daytime	22	0	0	0	68	32
Nighttime	8	13	0	0	12	75
Time unknown	3	0	0	0	67	33
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	33	3	0	9	55	33
Daytime	22	0	0	5	68	27
Nighttime	8	13	0	12	25	50
Time unknown	3	0	0	33	33	34
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	33	3	0	0	52	45
Daytime	22	0	0	0	59	41
Nighttime	8	13	0	0	25	62
Time unknown	3	0	0	0	67	33

Table 23 identifies the combined results from the PVD and PDX pilots who evaluated the CONSTRUCTION AHEAD sign. Sixteen pilots completed the evaluation.

Table 23. Combined Pilot Results—CONSTRUCTION AHEAD Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	33	6	3	6	45	39
Daytime	15	13	0	0	40	47
Nighttime	5	0	0	0	60	40
Time unknown	13	0	8	15	46	31
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	33	3	0	12	49	36
Daytime	15	7	0	13	27	54
Nighttime	5	0	0	20	60	20
Time unknown	13	0	0	8	69	23
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	33	3	0	6	52	39
Daytime	15	7	0	0	46	47
Nighttime	5	0	0	20	60	20
Time unknown	13	0	0	8	54	38

Table 24 identifies the combined results from the PVD, PDX, and SFB pilots who evaluated the CONSTRUCTION ON RAMP sign. Eighteen pilots completed the evaluation.

Table 24. Combined Pilot Results—CONSTRUCTION ON RAMP Sign

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	18	6	0	11	22	61
Daytime	13	8	0	0	30	62
Nighttime	4	0	0	25	0	75
Time unknown	1	0	0	100	0	0
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	18	0	0	11	28	61
Daytime	13	0	0	0	31	69
Nighttime	4	0	0	25	0	75
Time unknown	1	0	0	100	0	0
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	18	0	0	11	33	56
Daytime	13	0	0	0	38	62
Nighttime	4	0	0	25	25	50
Time unknown	1	0	0	100	0	0

Table 25 depicts opinions towards both versions of the TORA signage, including the RWY XX TORA XXXX FT sign evaluated at PDX and the RWY XX TAKEOFF RUN AVAILABLE XXXX FT signs evaluated at JFK. Twenty-seven individuals evaluated TORA signs at these airports.

Table 25. Combined Results—TORA Signage

	Number of Responses	Strongly Disagree (%)	Disagree (%)	Undecided (%)	Agree (%)	Strongly Agree (%)
Statement 1: The sign was conspicuous.						
All conditions	27	0	8	0	59	33
Daytime	9	0	11	0	44	44
Nighttime	5	0	20	0	60	20
Time unknown	13	0	0	0	69	31
Statement 2: The sign was comprehensible at an adequate distance.						
All conditions	27	0	4	15	59	22
Daytime	9	0	0	0	67	33
Nighttime	5	0	20	40	20	20
Time unknown	13	0	0	15	69	15
Statement 3: The sign adequately notified me of the existing construction.						
All conditions	27	4	4	4	55	33
Daytime	9	0	0	11	33	56
Nighttime	5	20	0	0	60	20
Time unknown	13	0	8	0	69	23

8. CONCLUSIONS.

Site visits were conducted to existing construction sites at several airports to collect information regarding the airport's existing airfield construction projects. No shortfalls with respect to compliance with the related Advisory Circulars (ACs) were identified. Several types of visual aids were used at the airports in accordance with AC 150/5370-2 to alert pilots and airport personnel of approaching closures or construction. These included lighted Xs, barricades with red solar-powered lights, and flags and cones. The airport operators indicated that in addition to using the current visual aids, found in AC 150/5370-2F, the use of the temporary safety orange signs would be advantageous if available.

Overall, vehicle operators and pilots overwhelmingly agreed the messages, character heights, and colors of the signs (CONSTRUCTION AHEAD, CONSTRUCTION ON RAMP, and TAKEOFF RUN AVAILABLE (TORA)) were comprehensible, conspicuous, and adequate in alerting individuals about existing construction.

- Of the combined total of 131 respondents (98 vehicle operators and 33 pilots), 114 respondents (87%), strongly agreed or agreed that the CONSTRUCTION AHEAD sign was conspicuous; 116 (88%) agreed or strongly agreed that the sign was comprehensible at an adequate distance. Of the combined respondents, 117 (89%) agreed or strongly agreed that the sign provided adequate notification of the existing construction.
- Of the combined total of 51 respondents, 47 (92%) agreed or strongly agreed that the CONSTRUCTION ON RAMP sign was conspicuous 45 (88%) agreed or strongly agreed that the sign was comprehensible at an adequate distance. Of the total respondents, 48 (94%) strongly agreed or agreed that the sign provided adequate notification of the existing construction.
- A total of 27 pilots and vehicle operators evaluated TORA signs providing takeoff run available information. Overall, 25 respondents (92%) agreed or strongly agreed that these signs were conspicuous; 22 respondents (81%) agreed or strongly agreed the signs were comprehensible at an adequate distance; and 24 respondents (89%) agreed or strongly agreed the signs adequately notified them of existing construction.

9. RECOMMENDATIONS.

Based on the results of this study, it is advised that AC 150/5370-2 be updated to include temporary safety orange construction signage as a visual aid to alert pilots and vehicle operators of existing airport construction. It is also recommended that signs displaying CONSTRUCTION ON RAMP and CONSTRUCTION AHEAD be placed at locations leading to ramps and other areas with construction activity. When a runway is temporarily shortened due to construction, it is recommended that TORA signs be placed at the runway entrances to display the current takeoff run available. Pilots and vehicle operators found both the legend text TORA and the legend text TAKEOFF RUN AVAILABLE acceptable for use on TORA signage. However, due to the increased length of the sign panel necessary to accommodate the additional characters of TAKEOFF RUN AVAILABLE, it is recommended that the acronym TORA be specified in the final sign design. The CONSTRUCTION AHEAD, CONSTRUCTION ON RAMP, and TORA signs should measure 30 inches high by 84 inches wide and the near side of the sign placed approximately 36 feet perpendicular to the taxiway pavement edge. Finally, it is recommended that additional education be conducted to increase understanding of the TORA acronym to ensure pilots have adequate situational awareness.

10. REFERENCES.

1. Federal Aviation Administration Air Traffic Organization “What’s on your runway? Airport Construction Advisory Council—Mitigating Hazards Associated with Airport Construction,” http://www.faa.gov/airports/runway_safety/runway_construction/media/ACAC_Guidance_2012.pdf (date last visited 08/11/2015).
2. Federal Aviation Administration, “Operational Safety on Airports During Construction,” Advisory Circular (AC) 150/5370-2F, September 29, 2011.
3. Federal Aviation Administration, “Notices to Airmen (NOTAMS) For Airport Operators,” AC 150/5200-28D, January 28, 2008.
4. Federal Aviation Administration, “Specification for Taxiway and Runway Signs,” AC 150/5345-44, January 5, 1994.
5. Air Line Pilots Association (ALPA) *FASTRead*, “FAA Evaluating New Construction Information Signs,” October 1, 2013, http://www3.alpa.org/portals/alpa/fastread/2013/FastRead_20131001.htm (date last visited 09/15/2015).

APPENDIX A—AIRPORT OPERATOR QUESTIONS

A.1 INTRODUCTION.

Researchers conducted site visits to Orlando Sanford International Airport (SFB) in Sanford, Florida, and Valkaria Airport (X59) in Grand-Valkaria, Florida, to collect information regarding the airports' existing airfield construction projects. Site visits consisted of a meeting with the airport operator and an airfield tour of the area that had the construction project in progress. During each site visit, the researchers asked the airport operator specific questions regarding background information on the airport's construction projects and if the airport was complying with relevant Advisory Circulars with regard to marking construction activities on the airport. Note: The purpose of this visit was to determine the need for improvement in alerting pilots and vehicle operators to the presence of construction areas. This appendix shows the researchers' questions for the airport operators.

A.2 ATTENDEES.

1. What areas on the airport were affected by the construction project?
2. Was the construction activity planned through project phasing, if so what did the phases consist of?
3. Are safety meetings held (weekly, bi-weekly)?
4. Are the construction contractor's responsibilities defined?
5. Are there copies of the Construction Safety and Phasing Plan (CSPP) and Safety Plan Compliance Document? Where are they located?
6. How does the airport restrict movement of the construction vehicles and personnel (e.g., barricading, erecting temporary fencing, or providing escorts)?
7. Does the Safety Plan Compliance Document include any supplemental information that could not be included in the CSPP prior to the contract award? If there was no supplemental information necessary for any specific subject, is the statement "No supplemental information" written after the corresponding subject title?
8. As for runway and taxiway visual aids, what equipment and methods were used for covering the signage and airfield lights? Equipment and methods for temporary closure markings (paint, fabric, other)?
9. As for protection of runway and taxiway safety areas including object-free areas, obstacle-free zones and approach/departure surfaces, what equipment or methods were used for maintaining the Taxiway Safety Area Standards? What methods were used to identify, demarcate, and protect airport surface including: equipment and methods for separation of construction operations from aircraft operations, including details of barricades?

10. Were construction safety drawings provided? If so, do they specifically indicate operational safety procedures and methods in affected areas for each construction phase?
11. Vehicle and Pedestrian Operations—how does the airport keep people and vehicles from restricted areas of the airport (i.e., what mechanisms prevent construction vehicles and workers from traveling to and from the worksite from unauthorized entry into the movement areas)?
12. What type of markings and signs are used for the access routes?
13. Is there a location of stockpiled construction materials? If so, where? Height restrictions?
14. Runway (RWY) and Taxiway (TWY) visual aids—were there any temporary RWY and TWY marking, lighting, signs and visual navigational aids required for construction? Were any existing marking, lighting, signs and visual aids that are temporarily, altered, obliterated, or shut down?

A.3 ADDITIONAL QUESTIONS AND COMMENTS.

- What visual aids/markings does the airport prefer to use?
- During the construction project, has there been any excavation?
- If excavation has occurred, when the contractor leaves for the day it is the excavation site filled?
- When did this construction project begin?
- During this construction project, besides using the current visual aids/markings are there additional visual aids that could have been used?

APPENDIX B—ORLANDO SANFORD INTERNATIONAL AIRPORT OPERATOR SITE VISIT QUESTIONS

B.1 INTRODUCTION.

Researchers performed a site visit to Orlando Sanford International Airport (SFB) Site on March 7, 2013. Below are the researchers' questions and the SFB airport operator's responses.

B.2 SITE VISIT QUESTIONS AND RESPONSES.

1. *What areas on the airport were affected by the construction project?*

Extended RWY 27R, TWY B and TWY C. Added a cul-de-sac in both directions on the highway at the RWY 27R end.

RWY 9L – New ILS, glideslope moved 75 feet north of runway

RWY 27R – upgraded ILS, Glideslope moved to the southside of the runway

2. *Was the construction activity planned through project phasing, if so what did the phases consist of?*

Yes. Refer to Phases on maps.

3. *Are safety meeting held (weekly, bi-weekly)?*

Held every week or when necessary. If a meeting that deals with signage or markings Tower personnel, contractor and engineer attends meeting.

4. *Are the construction contractor's responsibilities defined?*

Yes in the safety security plan.

5. *Are there copies of the Construction Safety and Phasing Plan and Safety Plan Compliance Document? Where are they located?*

Yes. The Vice President of Operations and Maintenance, ASC has a copy.

6. *How does the airport restrict movement of the construction vehicles and personnel (e.g., barricading, erecting temporary fencing or providing escorts)?*

The airport authority does not allow anyone on the movement area unless they are escorted by the airport authority. The following have access to the movement area: Airport Operations, Airport Maintenance, ARRF, NWS (long term people) and FAA Tech Ops assigned to the airport.

7. *Does the Safety Plan Compliance Document include any supplemental information that could not be included in the CSPP prior to the contract award? If there was no*

supplemental information is necessary for any specific subject, is the statement “No supplemental information” written after the corresponding subject title?

The Safety Plan Compliance Document does not include any supplemental information that could not be included in the CSPP prior to the contract award. The statement “No supplemental information” is not written in the corresponding subject title.

8. *As for runway and taxiway visual aids, what equipment and methods were used for covering the signage and airfield lights? Equipment and methods for temporary closure markings (paint, fabric, other)?*

Black Visqueen Plastic is duck taped around signs. During this construction project there were no lights that needed to be covered. In a previous construction project PVC pipe was placed over the lights.

As for temporary markings – chevrons were used on RWY 27R. For the first couple of days, snow fencing was used, but because of the winds and jet blast from the aircraft moved the chevrons. The contractor would have to move the snow fence back into position whenever it was not in the appropriate place. After a couple of days of this happening, the contractor suggested painting the chevrons on the RWY and to apply half application of paint.

9. *As for protection of runway and taxiway safety areas including object free areas, obstacle free zones and approach/departure surfaces, what equipment or methods were used for maintaining the Taxiway Safety Area Standards? What methods were used to identify, demarcate, and protect airport surface including: equipment and methods for separation of construction operations from aircraft operations, including details of barricades?*

If the contractor needs to work in the safety area, the airport authority closes that area until they complete the job.

10. *Construction safety drawings? If so, do they specifically indicate operational safety procedures and methods in affected areas for each construction phase?*

The airport authority has construction safety drawings.

11. *Vehicle and Pedestrian Operations—how does the airport keep people and vehicles from areas off the airport where they don’t belong (i.e., what mechanisms prevent construction vehicles and workers from traveling to and from the worksite from unauthorized entry into the movement areas)?*

Ops or maintenance escorts the vehicles.

12. *What type of markings and signs are used for the access routes?*

Construction folding horse with red flashing light outlines the access routes for the contractor. Contractor picks out signage to use for haul route. Airport authority approves it. No specific amount of distance between each signage. Contractor will have a meeting prior to using haul route and will go over what they plan to mark out route and location of route. For first drive through route all contractors follow the main driver to get accustomed to where to go and what the marking and signs that they need to follow.

13. *Is there a location of stockpiled construction materials? If so where? Height restrictions?*

Heights are based on location. Location not in the Part 77 surfaces.

14. *Runway (RWY) and Taxiway (TWY) visual aids—were there any temporary RWY and TWY marking, lighting, signs and visual navigational aids required for construction? Were any existing marking, lighting, signs and visual aids that are temporarily, altered, obliterated, or shut down?*

There were no temporary signs used during this construction project.

There are temporary runway threshold lights. New PAPIs installed on 27R

For the Flight Check that will take place on April 1st plywood will be painted white to represent temporary threshold.

B.3 ADDITIONAL QUESTIONS AND COMMENTS.

- *What visual aids/markings does the airport prefer to use?*

Barricades work best especially with solar powered lights. Those lights work best. Contractor and Ops checks to make sure lights work at night. Barricades are filled with water.

Other visual aids/ markings airport uses are lighted X's and construction cones.

- *When did this construction project begin?*

August 6, 2012.

- *During this construction project, besides using the current visual aids/markings would there be any additional visual aids that could've been used?*

TORA sign.

APPENDIX C—VALKARIA AIRPORT OPERATOR SITE VISIT QUESTIONS

C.1 INTRODUCTION.

Researchers performed a site visit to Valkaria Airport (X59) on March 8, 2013. Below are the researchers' questions and the X59 airport operator's responses.

C.2 SITE VISIT QUESTIONS AND RESPONSES.

1. *What areas on the airport were affected by the construction project?*

Entire airfield.

Constructing a new TWY parallel to RWY 14/32, this will be known as TWY Alpha. TWY Alpha will be 25 feet in width.

Pond project this will also serve as a storm water drainage (off airfield) – Removed trees to create a pond. This project is tied in the Apron project

Old Runway that was used during WWII located in the infield adjacent to RWY 10/28 removing the rock and using it for the BMX track in park area (off airport).

2. *Was the construction activity planned through project phasing, if so what did the phases consist of?*

Yes, see phasing plans from copies of CSPP

3. *Are safety meeting held (weekly, bi-weekly)?*

Every Thursday. There are three projects occurring at the same time. The timeframe of the meetings range from 1-2 hours depending what is being covered on the agenda.

4. *Are the construction contractor's responsibilities defined?*

Yes

5. *Are there copies of the Construction Safety and Phasing Plan and Safety Plan Compliance Document? Where are they located?*

Yes. A copy is located on the table in the Airport Administration office and the Resident Project Representative has a copy.

6. *How does the airport restrict movement of the construction vehicles and personnel (e.g., barricading, erecting temporary fencing or providing escorts)?*

The Superintendent is escorted on the airfield. While on the airfield, Airport Ops informs the Superintendent about the safety aspects of the airport. Furthermore, airport layout is discussed such as Runway and Taxiway intersections and boundaries of construction areas. The Superintendent is escorted on the airfield for about a week or two in order for

him/her to become familiar with the layout. The Superintendent in turn instructs his/her employees when driving on the airfield where they are supposed to be and where the danger areas are.

7. *Does the Safety Plan Compliance Document include any supplemental information that could not be included in the CSPP prior to the contract award? If there was no supplemental information is necessary for any specific subject, is the statement “No supplemental information” written after the corresponding subject title?*

The Safety Plan Compliance Document does not include any supplemental information that could not be included in the CSPP prior to the contract award.

8. *As for Runway and taxiway visual aids, what equipment and methods were used for covering the signage and airfield lights? Equipment and methods for temporary closure markings (paint, fabric, other)?*

Black tarp was used, but at this time all, the signs are removed from the construction site.

9. *As for protection of runway and taxiway safety areas including object free areas, obstacle free zones and approach/departure surfaces, what equipment or methods were used for maintaining the Taxiway Safety Area Standards? What methods were used to identify, demarcate, and protect airport surface including: equipment and methods for separation of construction operations from aircraft operations, including details of barricades?*

Orange cones are placed in those areas. If the orange cones need to be moved, Airport personnel will discuss with the Superintendent in that area the reason for them being moved and he/she will inform the rest of the construction workers. The airport believes that education is key for a successful construction project.

10. *Were construction safety drawings provided? If so, do they specifically indicate operational safety procedures and methods in affected areas for each construction phase?*

Yes, the airport has these drawings.

11. *Vehicle and Pedestrian Operations – How does the airport keep people and vehicles from areas of the airport where they do not belong (i.e., what mechanisms prevent construction vehicles and workers from traveling to and from the worksite from unauthorized entry into the movement areas)?*

The construction workers stay in their vehicles all day. During lunch, the construction workers stay by their vehicles and do not leave the airfield. At the end of the day, the construction vehicles are escorted off the airfield and left in the staging area overnight.

When a construction vehicle needs to enter the airfield, the construction vehicle waits at the gate on the ramp and waits until the flagger to signal him/her to enter onto the ramp and go to the construction area. When the construction vehicle is ready to leave the airfield, the construction vehicle stops in a specific area on the ramp and waits for the flagger to signal him/her to proceed off the ramp out the gate.

12. *What type of markings and signs are used for the access routes?*

Orange cones mark out the haul route. Haul route or any other areas that the construction vehicles transition onto, the airport requires a dirt ramp for the construction vehicles to go onto when entering the paved surfaces. The dirt is spread onto a portion of the pavement. This helps distribute the load of the vehicle to help prevent divots on the paved surfaces that are closed.

13. *Is there a location of stockpiled construction materials? If so where? Height restrictions?*

Behind the hangars which will be used for another project. The stockpile does not impede any of the surfaces or the building restriction line (BRL). The stockpile is one foot under the transitional surface.

There are stockpiles in-between the fence line and RWY 14/32. The stockpiles are removed no later than Friday of each week. The height they can go up to in that area is very low NTE 5Ft AGL.

14. *Runway (RWY) and Taxiway (TWY) visual aids—were there any temporary RWY and TWY marking, lighting, signs and visual navigational aids required for construction? Were any existing marking, lighting, signs and visual aids that are temporarily, altered, obliterated, or shut down?*

There were no temporary rwy and twy marking, lighting, signs and visual NAVAIDS required for construction. There were no existing marking, lighting, signs and visual aids that were temporarily, altered, obliterated, or shut down.

C.3 ADDITIONAL QUESTIONS AND COMMENTS.

· *When did the construction of TWY A start?*

January 6, 2013 completion date June 2013

· *What types of visual aids are used during the construction projects?*

RWY 14/32 is closed – There is a lighted ‘X’ placed on the numbers of the RWY, a couple of hundred feet past the numbers a yellow fabric ‘X’ is placed out on the centerline with sandbags for weight on each corner. Barricades with red solar colored lights are placed down further on the RWY.

Lights on Lighted 'X' are off during the day; the lights are turned on during the hours of 5pm – 8am.

When a new NOTAM is disseminated, as a courtesy, Airport Ops calls Florida Institute of Technology (FIT), FlightSafety, Chief Pilots and Safety Officers and inform these groups about the NOTAM. In addition to this, the NOTAM is faxed to all the groups to keep them updated on the construction changes at the airport.

Comment made by airport operator about NOTAMS: digital format that commercial airlines review if there is a new NOTAM (less than 48 hrs old) it should be eye catching to them. Possibly a different color.

Sweeper is used to clean debris on ramp during the day. All construction equipment have an orange and white checkered flag.

As for a potential safety orange visual aid airport operator liked the TORA sign.

APPENDIX D—SAFETY ORANGE PRESENTATION SLIDE COMMENT FORM

Before the simulated runs, the researchers briefed the pilots on the early stage signs via a slide presentation. The researchers collected the pilots' feedback on the signs in the following evaluation form, figure D-1.

Safety Orange Construction Signs during Airport Construction Presentation Slide Comments	
Name:	Date:
Early Stages - Signs	
Additional Signs Tested in Field not Shown in AFTIL	

Figure D-1. Safety Orange Presentation Slide Comment Form

APPENDIX E—CHARACTER COLOR AND LEGEND HEIGHT EVALUATION

Researchers evaluated the character color and legend height on proposed safety orange construction warning signs. They provided their feedback on the following form, figure E-1.

Safety Orange Construction Signs during Airport Construction Color Character and Height Evaluation	
Name:	Date:
<i>After evaluating the character colors that consists of two different heights on sign complete all of the following questions</i>	
1. At what distance did the sign become conspicuous? (top line)	
2. At what distance did the sign become conspicuous? (bottom line)	
3. Against the orange background, which color character do you prefer? Why?	
4. Other comments?	

Figure E-1. Character Color and Legend Height Evaluation Comment Form

APPENDIX F—PILOT EVALUATION AIRWAY FACILITIES TOWER INTEGRATION LABORATORY

Researchers worked with the Airway Facilities Tower Integration Laboratory to simulate several signs prior to field evaluations. Pilots evaluated computer-generated runs in a simulator. The runs included various types and locations of construction signage. Pilots validated the message on several safety orange construction signs and whether they preferred the black or white color character legend against the orange background and provided their feedback on the following form, figure 1.

Safety Orange Construction Signs during Airport Construction	
Name:	Date:
Pilot Category: GA CORP COMM	

After completing each run complete all of the following questions regarding specific signs in each run.

Run 1
Airport and control familiarization. No questions for this run.

Run 2 - Day
What does the message on the sign located on TWY B tell you? Was it easy to interpret? What do you think of the message on the sign?
Did you notice the sign prior to stopping? Does the location of the sign need improvement? If so how?
What does the message on the sign located on TWY B2 tell you? Was it easy to interpret? What do you think of the message on the sign?
Did you notice the sign prior to stopping? Does the location of the sign need improvement? If so how?
Run 2a – Sign Comparison
After observing signs that either have black or white characters on TWY B2, which color character do you prefer? Why?

Run 3 – Night
Did night time conditions impact the noticeability of the sign? If Yes, how so?
Run 4 - Day
What does the message on the sign located on TWY B tell you? Was it easy to interpret? What do you think of the message on the sign?
Did you notice the sign prior to stopping? Does the location of the sign need improvement? If so how?
Compared to the Construction Ahead sign in the previous run, which message do you prefer and why?
Run 4 - Day
What does the message on the sign located on TWY B2 tell you? Was it easy to interpret? What do you think of the message on the sign?
Did you notice the sign prior to stopping? Does the location of the sign need improvement? If so how?
Compared to the TORA sign in the previous run, which message do you prefer and why?
Run 5 - Night
Did night time conditions impact the noticeability of the sign? If Yes, how so?
Run 5a - Sign Comparison
After observing signs that either have black or white characters on TWY B2, which color character do you prefer? Why?
Run 6 - Day
What does the message on the sign located on TWY E3 tell you? Was it easy to interpret? What do you think of the message on the sign?

Did you notice the sign prior to stopping? Does the location of the sign need improvement? If so how?
Run 7 - Day
Did you notice the sign prior to stopping? How does this location compare to the previous location of the sign?

Figure F-1. Airway Facilities Tower Integration Laboratory Pilot Evaluation Form

APPENDIX G—LONG ISLAND MacARTHUR AIRPORT VEHICLE OPERATOR EVALUATION

G.1 INTRODUCTION.

Airport evaluations were performed to validate the effectiveness of the safety orange signs as to whether the addition of the signs increased the pilots and vehicle operators' awareness of construction while operating on the airfield. In addition to the visual aids currently being used by the airport operators, researchers installed one or more of the following safety orange construction signs: CONSTRUCTION AHEAD and/or CONSTRUCTION ON RAMP at Long Island MacArthur Airport (ISP). Figures G-1 through G-4 show the forms that were disseminated among vehicle operators and pilots at ISP to evaluate the signage under testing.

ISP SAFETY ORANGE CONSTRUCTION SIGNS VEHICLE OPERATOR EVALUATION					
Name: _____		Date: _____			
Time (Local): _____		Visibility: _____			
Please read each question as it relates to the effectiveness of the safety orange construction signs to increase the awareness of pilots and vehicle operators to existing construction on the airfield as a supplement to the visual aids that are being used.					
1. Which location did you observe a safety orange construction sign at ISP? _____ TWY S before the cutoff of TWY E _____ RWY 10 approaching west of RWY 33L					
2. The sign was conspicuous.					
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	
☐	☐	☐	☐	☐	
3. The sign was comprehensible at an adequate distance.					
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	
☐	☐	☐	☐	☐	
4. The sign adequately notified me of the existing construction.					
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	
☐	☐	☐	☐	☐	
5. Comments:					
Return the completed survey to: Pat O'Leary, email: POLeary@townofslip-ny.gov					
If you mail the hard copy send it to the following address: Long Island MacArthur Airport Airport Operations Division 100 Arrival Avenue, Suite 100 Ronkonkoma NY 11779					

Figure G-1. Vehicle Operator Evaluation Form for ISP

ISP SAFETY ORANGE CONSTRUCTION SIGNS PILOT EVALUATION

Name: _____	Date: _____
Time (Local): _____	Visibility: _____
Type of aircraft: _____	
Please read each question as it relates to the effectiveness of the safety orange construction signs to increase the awareness of pilots and vehicle operators to existing construction on the airfield as a supplement to the visual aids that are being used.	
1. Which location did you observe a safety orange construction sign at ISP? _____ TWY S before the cutoff of TWY E _____ RWY 10 approaching west of RWY 33L	
2. The sign was conspicuous. Strongly Disagree Disagree Undecided Agree Strongly Agree ☐ ☐ ☐ ☐ ☐	
3. The sign was comprehensible at an adequate distance. Strongly Disagree Disagree Undecided Agree Strongly Agree ☐ ☐ ☐ ☐ ☐	
4. The sign adequately notified me of the existing construction. Strongly Disagree Disagree Undecided Agree Strongly Agree ☐ ☐ ☐ ☐ ☐	
5. Comments: 	

Return the completed survey to: Jennifer Klass, A.A.E., e-mail: Jennifer_klass@sra.com.

If you mail the hard copy, send it to the following address:

SRA International
 1201 New Road Ste 242
 Linwood NJ 08221

Figure G-2. Pilot Evaluation Form for ISP—Hard Copy

ISP Safety Orange Signs during Airport Construction

The Federal Aviation Administration (FAA) is conducting evaluations to determine the effectiveness of the safety orange "Construction Ahead" signs in increasing the awareness of pilots and vehicle operators to existing construction on the airfield. The signs supplement the visual aids that are being used according to the AC 150/5370-2 Operational Safety on Airports during Construction.

A picture of Long Island MacArthur Airport (ISP) shows the two locations where the signs have been temporarily installed follows question number 2.

The locations of each sign are as follows:

"Construction Ahead"

- Taxiway (TWY) S before the cutoff of TWY E

"Construction Ahead"

- Runway (RWY) 10 approaching west of RWY 33L

This is a subjective evaluation. We are relying on your aviation background and experience to provide us with your opinion on the matter. Thank you for your cooperation and participation!

If you have any questions in regards to the survey please contact Jennifer Klass, A.A.E. at (609) 601-6800 Ext. 137 or email jennifer_klass@sra.com

1. Complete the following information: Date; Time (Local); Visibility; and Type of aircraft

Refer to picture of Long Island MacArthur Airport's airfield for statements 2-6.

Figure G-3. Pilot Evaluation for ISP—Electronic Form



2. Which location did you observe a safety orange construction sign? Check all that apply.

- ☐ TWY S before the cutoff of TWY E
☐ RWY 10 approaching west of RWY 33L

3. The sign was conspicuous.

Strongly Disagree Disagree Undecided Agree Strongly Agree

4. The sign was comprehensible at an adequate distance.

Strongly Disagree Disagree Undecided Agree Strongly Agree

5. The sign adequately notified me of the existing construction.

Strongly Disagree Disagree Undecided Agree Strongly Agree

6. Provide additional comments.

Figure G-4. Pilot Evaluation for ISP—Electronic Form, Page 2

APPENDIX H—THEODORE FRANCIS GREEN STATE AIRPORT VEHICLE OPERATOR EVALUATION

Airport evaluations were performed to validate the effectiveness of the safety orange signs as to whether the addition of the signs increased the pilots and vehicle operators' awareness of construction while operating on the airfield. In addition to the visual aids currently being used by the airport operators, researchers installed one or more of the following safety orange construction signs: CONSTRUCTION AHEAD and/or CONSTRUCTION ON RAMP at Theodore Francis Green State Airport (PVD). Figures H-1 through H-4 show the forms that were disseminated among vehicle operators and pilots at PVD to evaluate the signage under testing.

PVD SAFETY ORANGE CONSTRUCTION SIGNS VEHICLE OPERATOR EVALUATION

Name: _____	Date: _____
Time (Local): _____	Visibility: _____
Please read each question as it relates to the effectiveness of the safety orange construction signs to increase the awareness of pilots and vehicle operators to existing construction on the airfield as a supplement to the visual aids that are being used.	
1. Which location did you observe a safety orange construction sign at PVD? _____ TWY A near entrance to General Aviation Parking _____ TWY T, adjacent to the intersection with TWY N	
2. The sign was conspicuous.	
Strongly Disagree ☐	Disagree ☐
Undecided ☐	Agree ☐
Strongly Agree ☐	
3. The sign was comprehensible at an adequate distance.	
Strongly Disagree ☐	Disagree ☐
Undecided ☐	Agree ☐
Strongly Agree ☐	
4. The sign adequately notified me of the existing construction.	
Strongly Disagree ☐	Disagree ☐
Undecided ☐	Agree ☐
Strongly Agree ☐	
5. Comments:	

Return the completed survey to: Ron Stella, e-mail: RStella@pvdairport.com

If you mail the hard copy, send it to the following address:
 TF Green State Airport
 2000 Post Road
 Warwick, RI 02886

Figure H-1. Vehicle Operator Evaluation Form for PVD

PVD SAFETY ORANGE CONSTRUCTION SIGNS PILOT EVALUATION

Name: _____	Date: _____
Time (Local): _____	Visibility: _____
Type of aircraft: _____	

Please read each question as it relates to the effectiveness of the safety orange construction signs to increase the awareness of pilots and vehicle operators to existing construction on the airfield as a supplement to the visual aids that are being used.

- Which location did you observe a safety orange construction sign AT PVD?
 _____ TWY A near entrance to General Aviation Parking
 _____ TWY T, adjacent to the intersection with TWY N
- The sign was conspicuous.

Strongly Disagree ☐	Disagree ☐	Undecided ☐	Agree ☐	Strongly Agree ☐
---	--------------------------------------	---------------------------------------	-----------------------------------	--
- The sign was comprehensible at an adequate distance.

Strongly Disagree ☐	Disagree ☐	Undecided ☐	Agree ☐	Strongly Agree ☐
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- The sign adequately notified me of the existing construction.

Strongly Disagree ☐	Disagree ☐	Undecided ☐	Agree ☐	Strongly Agree ☐
---	--------------------------------------	---------------------------------------	-----------------------------------	--
- Comments:

Return the completed survey to: Jennifer Klass, A.A.E., e-mail: Jennifer_klass@sra.com

If you mail the hard copy, send it to the following address:

SRA International
1201 New Road Ste 242
Linwood NJ 08221

Figure H-2. Pilot Evaluation Form for PVD—Hard Copy

PVD Safety Orange Signs during Airport Construction

The Federal Aviation Administration (FAA) is conducting evaluations to determine the effectiveness of the safety orange "Construction Ahead" and "Construction on Ramp" signs in increasing the awareness of pilots and vehicle operators to existing construction on the airfield. The signs supplement the visual aids that are being used according to the AC 150/5370-2 Operational Safety on Airports during Construction.

A picture of Theodore Francis Green State Airport (PVD) with the location of the two signs follows question number 2.

The locations of each signs are as follows:

"Construction on Ramp"

- Taxiway (TWY) A near entrance to General Aviation Parking

"Construction Ahead"

- TWY T, adjacent to the intersection with TWY N

This is a subjective evaluation. We are relying on your aviation background and experience to provide us with your opinion on the matter. Thank you for your cooperation and participation!

If you have any questions in regards to the survey please contact Jennifer Klass, A.A.E. at (609) 601-6800 Ext. 137 or email jennifer_klass@sra.com

1. Complete the following information: Date; Time (Local); Visibility; and Type of aircraft

Refer to the picture of Theodore Francis Green State Airport's airfield for statements 2-6

Figure H-3. Pilot Evaluation for PVD—Electronic Form



2. Which location did you observe a safety orange construction sign? Check sign location that applies.

- ☐ TWY A near entrance to General Aviation Parking
☐ TWY T, adjacent to the intersection with TWY N

3. The sign was conspicuous.

Strongly Disagree Disagree Undecided Agree Strongly Agree

4. The sign was comprehensible at an adequate distance.

Strongly Disagree Disagree Undecided Agree Strongly Agree

5. The sign adequately notified me of the existing construction.

Strongly Disagree Disagree Undecided Agree Strongly Agree

6. Provide additional comments.

Figure H-4. Pilot Evaluation for PVD—Electronic Form, Page 2

APPENDIX I—CHICAGO O’HARE INTERNATIONAL AIRPORT VEHICLE OPERATOR EVALUATION

Airport evaluations were performed to validate the effectiveness of the safety orange signs as to whether the addition of the signs increased the pilots and vehicle operators’ awareness of construction while operating on the airfield. In addition to the visual aids currently being used by the airport operators, researchers installed one or more of the following safety orange construction signs: CONSTRUCTION AHEAD and/or CONSTRUCTION ON RAMP at Chicago O’Hare International Airport (ORD). Figures I-1 through I-4 show the forms that were disseminated among vehicle operators and pilots at ORD to evaluate the signage under testing.

ORD SAFETY ORANGE CONSTRUCTION SIGNS VEHICLE OPERATOR EVALUATION

Name: _____	Date: _____
Time (Local): _____	Visibility: _____
Please read each question as it relates to the effectiveness of the safety orange construction signs to increase the awareness of pilots and vehicle operators to existing construction on the airfield as a supplement to the visual aids that are being used.	
1. Which location did you observe a safety orange construction sign at ORD? _____ TWY C1, adjacent to intersection with TWY C _____ TWY Z, adjacent to the intersection with TWY C	
2. The sign was conspicuous. Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree ☐	
3. The sign was comprehensible at an adequate distance. Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree ☐	
4. The sign adequately notified me of the existing construction. Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree ☐	
5. Comments:	

Return the completed survey to: Ray Hoffelt, e-mail: ray.hoffelt@cityofchicago.org

Return hard copy to:

City Tower / Atrium
Attn: Ray Hoffelt, Chief Airport Operations Supervisor

Figure I-1. Vehicle Operator Evaluation Form for ORD

ORD SAFETY ORANGE CONSTRUCTION SIGNS PILOT EVALUATION

Name: _____	Date: _____
Time (Local): _____	Visibility: _____
Type of aircraft: _____	
Please read each question as it relates to the effectiveness of the safety orange construction signs to increase the awareness of pilots and vehicle operators to existing construction on the airfield as a supplement to the visual aids that are being used.	
1. Which location did you observe a safety orange construction sign at ORD? _____ TWY C1, adjacent to intersection with TWY C _____ TWY Z, adjacent to the intersection with TWY C	
2. The sign was conspicuous.	
Strongly Disagree ☐	Disagree ☐
Undecided ☐	Agree ☐
Strongly Agree ☐	
3. The sign was comprehensible at an adequate distance.	
Strongly Disagree ☐	Disagree ☐
Undecided ☐	Agree ☐
Strongly Agree ☐	
4. The sign adequately notified me of the existing construction.	
Strongly Disagree ☐	Disagree ☐
Undecided ☐	Agree ☐
Strongly Agree ☐	
5. Comments:	

Return the completed evaluation to: Jennifer Klass, A.A.E. e-mail: Jennifer_klass@sra.com

If you mail the hard copy, send it to the following address:

Jennifer Klass, A.A.E.
 SRA International
 1201 New Road Ste 242
 Linwood NJ 08221

Figure I-2. Pilot Evaluation Form for ORD—Hard Copy

ORD Safety Orange Signs during Airport Construction

The Federal Aviation Administration (FAA) is conducting evaluations to determine the effectiveness of the safety orange "Construction Ahead" signs in increasing the awareness of pilots and vehicle operators to existing construction on the airfield. The signs supplement the visual aids that are being used according the AC 150/5370-2 Operational Safety on Airports during Construction.

A picture of Chicago O'Hare International Airport (ORD) with the location of the two signs follows question number 2.

The locations of each signs are as follows:

"Construction Ahead"

- Taxiway (TWY) C1, adjacent to intersection with TWY C

"Construction Ahead"

- TWY Z, adjacent to the intersection with TWY C

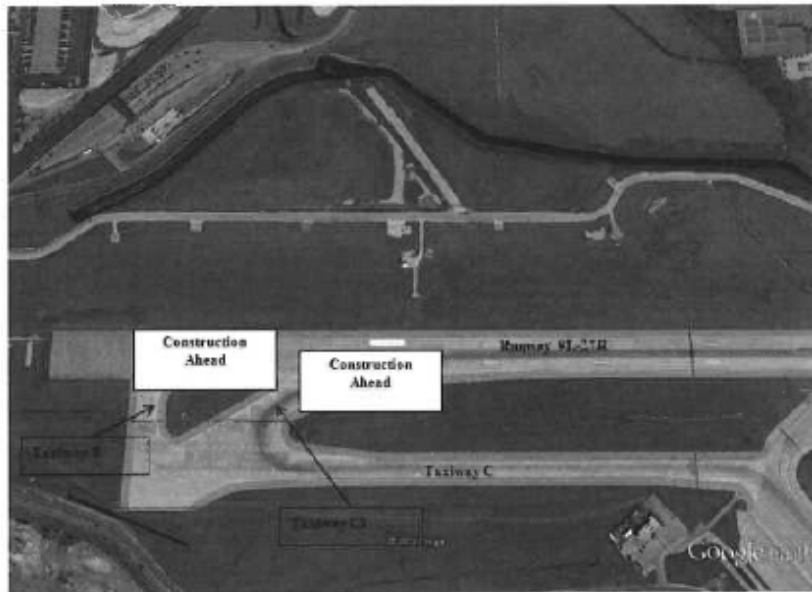
This is a subjective evaluation. We are relying on your aviation background and experience to provide us with your opinion on the matter. Thank you for your cooperation and participation!

If you have any questions in regards to the survey please contact Jennifer Klass, A.A.E. at (609) 601-6800 Ext. 137 or email jennifer_klass@sra.com

1. Complete the following information: Date; Time (Local); Visibility; and Type of aircraft

For statements/questions 2-6, refer to picture of ORD

Figure I-3. Pilot Evaluation for ORD—Electronic Form



2. Which location did you observe a safety orange construction sign? Check all that apply.

- ☐ TWY C1, adjacent to intersection with TWY C
- ☐ TWY Z, adjacent to the intersection with TWY C

3. The sign was conspicuous.

Strongly Disagree Disagree Undecided Agree Strongly Agree

4. The sign was comprehensible at an adequate distance.

Strongly Disagree Disagree Undecided Agree Strongly Agree

5. The sign adequately notified me of the existing construction.

Strongly Disagree Disagree Undecided Agree Strongly Agree

6. Provide additional comments.

Done

Figure I-4. Pilot Evaluation for ORD—Electronic Form, Page 2

APPENDIX J—PORTLAND INTERNATIONAL AIRPORT VEHICLE OPERATOR EVALUATION

Airport evaluations were performed to validate the effectiveness of the safety orange signs as to whether the addition of the signs increased the pilots and vehicle operators' awareness of construction while operating on the airfield. In addition to the visual aids currently being used by the airport operators, researchers installed one or more of the following safety orange construction signs: CONSTRUCTION AHEAD and/or CONSTRUCTION ON RAMP at Portland International Airport (PDX). Figures J-1 through J-4 show the forms that were disseminated among vehicle operators and pilots at PDX to evaluate the signage under testing.

Name: _____		Date: _____	
Time (Local): _____		Visibility: _____	
Please read each question as it relates to the effectiveness of the safety orange construction signs to increase the awareness of pilots and vehicle operators to existing construction on the airfield as a supplement to the visual aids that are being used.			
1. Which location did you observe a safety orange construction sign at PDX? _____ Taxiway (TWY) C between TWY C5 and TWY C6 _____ TWY E5 north side of taxiway			
2. The sign was conspicuous. Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree ☐			
3. The sign was comprehensible at an adequate distance. Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree ☐			
4. The sign adequately notified me of the existing construction. Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree ☐			
5. Comments:			

Return the completed survey to: Tom Horton, C.M., ACE, Airside Operations Planner; e-mail
Thomas.Horton@portofportland.com

If you mail the hard copy send it to the following address:
 Tom Horton, C.M., ACE
 Portland International Airport
 PO Box 3529
 Portland, OR 97208

Figure J-1. Vehicle Operator Evaluation Form for PDX

PDX SAFETY ORANGE CONSTRUCTION SIGNS PILOT EVALUATION

Name: _____		Date: _____		
Time (Local): _____		Visibility: _____		
Type of aircraft: _____				
Please read each question as it relates to the effectiveness of the safety orange construction signs to increase the awareness of pilots and vehicle operators to existing construction on the airfield as a supplement to the visual aids that are being used.				
1. Which location did you observe a safety orange construction sign at PDX? _____ Taxiway (TWY) C between TWY C5 and TWY C6 _____ TWY E5 north side of taxiway				
2. The sign was conspicuous.				
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐
3. The sign was comprehensible at an adequate distance.				
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐
4. The sign adequately notified me of the existing construction.				
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐
5. Comments:				

Return the completed survey to: Tom Horton, C.M., ACE, Airside Operations Planner; e-mail
 Thomas.Horton@portofportland.com

If you mail the hard copy send it to the following address:
 Tom Horton, C.M., ACE
 Portland International Airport
 PO Box 3529
 Portland, OR 97208

Figure J-2. Pilot Evaluation Form for PDX—Hard Copy

PDX Safety Orange Signs during Airport Construction

The Federal Aviation Administration (FAA) is conducting evaluations to determine the effectiveness of the safety orange "Construction Ahead" and "Construction on Ramp" signs in increasing the awareness of pilots and vehicle operators to existing construction on the airfield. The signs supplement the visual aids that are being used according the AC 150/5370-2 Operational Safety on Airports during Construction.

A picture of Portland International Airport (PDX) with the location of the two signs follows question number 2.

The locations of each signs are as follows:

"Construction on Ramp"

- TWY E5 north side of taxiway

"Construction Ahead"

- Taxiway (TWY) C between TWY C5 and TWY C6

This is a subjective evaluation. We are relying on your aviation background and experience to provide us with your opinion on the matter. Thank you for your cooperation and participation!

If you have any questions in regards to the survey please contact Jennifer Klass, A.A.E. at (609) 601-6800 Ext. 137 or email jennifer_klass@sra.com

1. Complete the following information: Date; Time (Local); Visibility; and Type of aircraft

For statements/questions 2 - 6, refer to picture of PDX.

Figure J-3. Pilot Evaluation for PDX—Electronic Form



2. Which location did you observe a safety orange construction sign? Check sign location that applies.

- ☐ TWY C between TWY C5 and TWY C6
- ☐ TWY E5 north side of taxiway

3. The sign was conspicuous.

Strongly Disagree Disagree Undecided Agree Strongly Agree

4. The sign was comprehensible at an adequate distance.

Strongly Disagree Disagree Undecided Agree Strongly Agree

5. The sign adequately notified me of the existing construction.

Strongly Disagree Disagree Undecided Agree Strongly Agree

6. Provide additional comments.

Figure J-4. Pilot Evaluation for PDX—Electronic Form, Page 2

APPENDIX K—ORLANDO SANFORD INTERNATIONAL AIRPORT VEHICLE OPERATOR EVALUATION

Airport evaluations were performed to validate the effectiveness of the safety orange signs as to whether the addition of the signs increased the pilots and vehicle operators' awareness of construction while operating on the airfield. In addition to the visual aids currently being used by the airport operators, researchers installed one or more of the following safety orange construction signs: CONSTRUCTION AHEAD and/or CONSTRUCTION ON RAMP at Orlando Sanford International Airport (SFB). Figures K-1 through K-4 show the forms that were disseminated among vehicle operators and pilots at SFB to evaluate the signage under testing.

SFB SAFETY ORANGE CONSTRUCTION SIGNS VEHICLE OPERATOR EVALUATION					
Name: _____		Date: _____			
Time (Local): _____		Visibility: _____			
Please read each question as it relates to the effectiveness of the safety orange construction signs to increase the awareness of pilots and vehicle operators to existing construction on the airfield as a supplement to the visual aids that are being used.					
1. Which location did you observe a safety orange construction sign at SFB? _____ On Terminal Apron North Side _____ On Terminal Apron South Side					
2. The sign was conspicuous. Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree ☐					
3. The sign was comprehensible at an adequate distance. Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree ☐					
4. The sign adequately notified me of the existing construction. Strongly Disagree ☐ Disagree ☐ Undecided ☐ Agree ☐ Strongly Agree ☐					
5. Comments:					

Return the completed survey to: George D Speake, Jr, C.M., e-mail: gspeake@osaa.net.

If you mail the hard copy, send it to the following address:
 George D Speake, Jr, C.M.
 VP of Operations & Maintenance
 Airport Security Coordinator
 Sanford Airport Authority
 1200 Red Cleveland Blvd
 Sanford, FL 32773

Figure K-1. Vehicle Operator Evaluation Form for SFB

SFB SAFETY ORANGE CONSTRUCTION SIGNS PILOT EVALUATION

Name: _____	Date: _____										
Time (Local): _____	Visibility: _____										
Type of aircraft: _____											
Please read each question as it relates to the effectiveness of the safety orange construction signs to increase the awareness of pilots and vehicle operators to existing construction on the airfield as a supplement to the visual aids that are being used.											
1. Which location did you observe a safety orange construction sign at SFB? _____ On Terminal Apron North Side _____ On Terminal Apron South Side											
2. The sign was conspicuous. <table> <tr> <td>Strongly Disagree</td> <td>Disagree</td> <td>Undecided</td> <td>Agree</td> <td>Strongly Agree</td> </tr> <tr> <td>☐</td> <td>☐</td> <td>☐</td> <td>☐</td> <td>☐</td> </tr> </table>		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree							
☐	☐	☐	☐	☐							
3. The sign was comprehensible at an adequate distance. <table> <tr> <td>Strongly Disagree</td> <td>Disagree</td> <td>Undecided</td> <td>Agree</td> <td>Strongly Agree</td> </tr> <tr> <td>☐</td> <td>☐</td> <td>☐</td> <td>☐</td> <td>☐</td> </tr> </table>		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree							
☐	☐	☐	☐	☐							
4. The sign adequately notified me of the existing construction. <table> <tr> <td>Strongly Disagree</td> <td>Disagree</td> <td>Undecided</td> <td>Agree</td> <td>Strongly Agree</td> </tr> <tr> <td>☐</td> <td>☐</td> <td>☐</td> <td>☐</td> <td>☐</td> </tr> </table>		Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	☐	☐	☐	☐	☐
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree							
☐	☐	☐	☐	☐							
5. Comments: 											

Return the completed survey to: George D Speake, Jr, C.M., e-mail: gspeake@osaa.net.

If you mail the hard copy, send it to the following address:
 George D Speake, Jr, C.M.
 VP of Operations & Maintenance
 Airport Security Coordinator
 Sanford Airport Authority
 1200 Red Cleveland Blvd
 Sanford, FL 32773

Figure K-2. Pilot Evaluation Form for SFB—Hard Copy

SFB Safety Orange Signs during Airport Construction

The Federal Aviation Administration (FAA) is conducting evaluations at Orlando Sanford International Airport (SFB) to determine the effectiveness of safety orange construction signs in increasing the awareness of pilots and vehicle operators to existing construction on the airfield. The safety orange construction signs will act as an additional visual aid to the Hazard Marking, Lighting, and Signing section within Advisory Circular (AC) 150/5370-2F, Operational Safety on Airports during Construction.

A picture of Orlando Sanford International Airport (SFB) with the location of the two signs follows question number 2.

The locations of each sign are as follows:

- On Terminal Apron North Side
- On Terminal Apron South Side

This is a subjective evaluation and we are relying on your aviation background and experience to provide us with your opinion on this matter.

Thank you for your participation and cooperation.

If you have, any questions in regards to the survey please contact Jennifer Klass, A.A.E. at (609) 601-6800 Ext.137, or email: Jennifer_klass@sra.com.

1. Complete the following information: Date; Time (Local); Visibility; and Type of Aircraft

Refer to the picture of Orlando Sanford International Airport's Terminal Ramp for statements 2-6



Figure K-3. Pilot Evaluation for SFB—Electronic Form

2. Which location did you observe a safety orange construction sign? check sign location(s) that applies.

- ☐ On Terminal Apron North Side
- ☐ On Terminal Apron South Side

3. The sign was conspicuous.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Undecided
- ☐ Agree
- ☐ Strongly Agree

4. The sign was comprehensible at an adequate distance.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Undecided
- ☐ Agree
- ☐ Strongly Agree

5. The sign adequately notified me of the existing construction.

- ☐ Strongly Disagree
- ☐ Disagree
- ☐ Undecided
- ☐ Agree
- ☐ Strongly Disagree

6. Provide additional comments.

Done

Figure K-4. Pilot Evaluation for SFB—Electronic Form, Page 2

APPENDIX L—JOHN F. KENNEDY INTERNATIONAL AIRPORT EVALUATION

Researchers installed one or more of the following safety orange construction signs: CONSTRUCTION AHEAD and/or TAKEOFF RUN AVAILABLE at John F. Kennedy International Airport (JFK). The following form (figures L-1 through L-5) was disseminated via hard copy among vehicle operators and pilots at JFK to evaluate the signage under testing.

JFK Construction Signage

The Federal Aviation Administration (FAA) is conducting evaluations to determine the effectiveness of temporary "Construction Ahead" and "Takeoff Run Available" (TORA) orange signs in increasing the awareness of pilots and vehicle operators about existing construction on the airfield and temporarily-reduced runway length. The signs supplement the visual aids that are being used according to the AC 150/5370-2 Operational Safety on Airports during Construction.

The locations of the signs are as follows:

"Construction Ahead"

TWY E at RWY 22R (East side of RWY)
TWY FB at RWY 22R (East side of RWY)
TWY YA at RWY 22R (East side of RWY)
TWY E at TWY C
TWY ZA at TWY A

"Takeoff Run Available"

TWY YA @ RWY 22R (West side of RWY)
TWY YA @ RWY 22R (East side of RWY)
TWY K @ RWY 4L

This is a subjective evaluation. We are relying on your aviation background and experience to provide us with your opinion on the matter. Thank you for your cooperation and participation!

If you have any questions in regards to the survey please contact Garrison Canter at (609) 601-6800 Ext. 117 or garrison_canter@sra.com

1. Have you observed orange signs when taxiing on the airfield, including (but not limited to) those located at the points shown above?

☐ Yes

☐ No

Figure L-1. Pilot and Vehicle Operator Evaluation Form for JFK, Page 1

JFK Construction Signage

2. Which type of orange signage did you observe?

☐ "Construction Ahead"

☐ "Takeoff Run Available"

☐ Both

Figure L-2. Pilot and Vehicle Operator Evaluation Form for JFK, Page 2

JFK Construction Signage	
Construction Ahead	
3. Please complete the following information: Date; Time (Local); Visibility; and Type of aircraft. 	
4. The "Construction Ahead" sign was conspicuous. Strongly Disagree Disagree Undecided Agree Strongly Agree ☐ ☐ ☐ ☐ ☐	
5. The "Construction Ahead" sign was comprehensible at an adequate distance. Strongly Disagree Disagree Undecided Agree Strongly Agree ☐ ☐ ☐ ☐ ☐	
6. The "Construction Ahead" sign adequately notified me of the existing construction. Strongly Disagree Disagree Undecided Agree Strongly Agree ☐ ☐ ☐ ☐ ☐	
7. Please provide any further comments or concerns you may have regarding the "Construction Ahead" sign. 	

Figure L-3. Pilot and Vehicle Operator Evaluation Form for JFK, Page 3

JFK Construction Signage

TORA

8. Please complete the following information: Date; Time (Local); Visibility; and Type of aircraft.

9. The "Takeoff Run Available" sign was conspicuous.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐

10. The sign was comprehensible at an adequate distance.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐

11. The sign adequately notified me of the distance available for takeoff.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐

12. Please provide any further comments or concerns you may have regarding the "Takeoff Run Available" sign.

Figure L-4. Pilot and Vehicle Operator Evaluation Form for JFK, Page 4

JFK Construction Signage

13. Please complete the following information: Date; Time (Local); Visibility; and Type of aircraft.

14. The "Construction Ahead" sign was conspicuous.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐

15. The "Construction Ahead" sign was comprehensible at an adequate distance.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐

16. The "Construction Ahead" sign adequately notified me of the existing construction.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐

17. The "Takeoff Run Available" sign was conspicuous.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐

18. The "Takeoff Run Available" sign was comprehensible at an adequate distance.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐

19. The "Takeoff Run Available" sign adequately notified me of the distance available on the runway for takeoff.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
☐	☐	☐	☐	☐

20. Please provide any further comments or concerns you may have regarding the "Construction Ahead" and/or "Takeoff Run Available" sign.

Figure L-5. Pilot and Vehicle Operator Evaluation Form for JFK, Page 5