Minnesota Department of Transportation

RESEARCH SERVICES & LIBRARY

Office of Transportation System Management

Implementation of Automatic Flagger Assistance Devices (AFADs) for Minnesota Department of Transportation Flagger Operations

Edward F. Terhaar, Principal Investigator
Wenck Associates, Inc.

December 2014

Research Project
Final Report 2014-44

To request this document in an alternative format call 651-366-4718 or 1-800-657-3774 (Greater Minnesota) or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

Technical Report Documentation Page

1. Report No.	2.	3. Recipients Accession No.	
MN/RC 2014-44			
4. Title and Subtitle Implementation of Automatic Flagger Assistance Devices (AFADs) for Minnesota Department of Transportation Flagger Operations		5. Report Date December 2014 6.	
7. Author(s) Edward F. Terhaar		8. Performing Organization Report No.	
9. Performing Organization Name and Address Wenck Associates, Inc. 1800 Pioneer Creek Center Maple Plain, MN 55359		10. Project/Task/Work Unit No. 11. Contract (C) or Grant (G) No. (C) 03715	
12. Sponsoring Organization Name and Address Minnesota Department of Transportation Research Services & Library 395 John Ireland Boulevard, MS 330 St. Paul, Minnesota 55155-1899		13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code	
15. Supplementary Notes http://www.lrrb.org/pdf/201444.pdf			

16. Abstract (Limit: 250 words)

Flagging operations are a critical part of construction and maintenance activities on our highways. Flagging personnel are trained to effectively and safely communicate the location of construction or maintenance activities to the traveling public. Due to the nature of the work, flagging personnel are located on the roadway near the work zone, which can result in dangerous situations. With the increasing levels of distracted drivers, safety of flaggers and workers in work zones is an increasing concern. Unfortunately, flagging personnel deaths and near misses continue to occur on our highways during each construction season.

Automated Flagger Assistance Devices (AFADs) are portable traffic control devices used by flagging personnel instead of traditional flagging equipment. The Minnesota Department of Transportation Research Services section purchased three sets of AFADs for district use. The objective of this research project was to explore the use of the equipment and demonstrate utility. Research shows that it is safer to pull flagger personnel out of traffic using these devices. However, based on conversations with MnDOT personnel, there has been resistance in the past using these devices on a regular basis.

17. Document Analysis/Descriptors	18. Availability Statement		
Flaggers, Road crews, Automated Flagger Assistance Devices, Work zones, Work zone safety, Traffic safety	No restrictions. Document available from: National Technical Information Services, Alexandria, Virginia 22312		
19. Security Class (this report) Unclassified	20. Security Class (this page) Unclassified	21. No. of Pages 35	22. Price

Implementation of Automatic Flagger Assistance Devices (AFADs) for Minnesota Department of Transportation Flagger Operations

Prepared by:

Edward F. Terhaar
Wenck Associates, Inc.

December 2014

Published by:

Minnesota Department of Transportation
Research Services & Library
395 John Ireland Boulevard, MS 330
St. Paul, Minnesota 55155-1899

Acknowledgments

The author would like to thank Alan Rindels, Tom Dumont, Jeremy Gjovik, Randy Reznicek, and Jason Penaz of MnDOT for their assistance on this project. The author also thanks MnDOT Research Services, MnDOT District 3, MnDOT District 8, MnDOT Metro District, and Dave Jones and Charles Fanslow of Safety Technologies, Inc., for their assistance.

Table of Contents

List of Figures

Executive Summary

Flagging operations are a critical part of construction and maintenance activities on our highways. Flagging personnel are trained to effectively and safely communicate the location of construction or maintenance activities to the traveling public. Due to the nature of the work, flagging personnel are located on the roadway near the work zone, which can result in dangerous situations. With the increasing levels of distracted drivers, safety of flaggers and workers in work zones is an increasing concern. Unfortunately, flagging personnel deaths and near misses continue to occur on our highways during each construction season.

Automatic Flagger Assistance Devices (AFADs) are portable traffic control devices used by flagging personnel instead of traditional flagging equipment. The Minnesota Department of Transportation (MnDOT) Research Services section purchased three sets of AFADs for district use. The objective of this research project was to explore the use of the equipment and demonstrate utility. Research shows that it is safer to pull flagger personnel out of traffic using these devices. However, based on conversations with MnDOT personnel, there has been resistance in the past using these devices on a regular basis.

Two training sessions were held to introduce the AFADs to MnDOT personnel. Training session #1 was held in St. Cloud, Minn. and was attended by 26 people, including 24 MnDOT employees from Districts 3 and 8. The session included a presentation on the AutoFlagger, hands on viewing and demonstration of the AutoFlagger devices, and discussion of initial impressions, perceived limitations, and next steps.

Training session #2 was held at MnROAD and was attended by 35 people, including 33 MnDOT employees from Districts 3, 8, and Metro. The session agenda included a slide presentation on the device details, the overall work zone setup, operation of the device, hands-on operations outside on the MnROAD test track, and discussion in classroom

Field operations for various flagging operations were observed and documented. Operations utilizing both traditional flagging and AFADs were included in the documentation phase. Major points included in the documentation were:

- Observe each flagging operation in the field to document the procedures used during setup, field operation, and take down.
- Document the amount of time needed for each operation.
- Place major emphasis on the AFAD operation and maintenance, including safety benefits, operational issues, ease of use, hindrance of use, effectiveness of the devices, driver reactions, etc.

Based on the observations and interviews described in this report, the following conclusions were made:

- AFADs work well on two-lane roads.
- One set of AFADs can be operated by one person under certain conditions.
- Worst-case scenario requires two people to operate one AFAD set. Personnel are removed from traffic while operating.
- Setup and take down require more effort than traditional flagging but are still considered reasonable.
- More research is needed to determine if mobile operations are possible.
- Overall the AFADs were very popular with maintenance staff.
- The AF-76 is preferred at locations with wide shoulders. The AF-54 works well at locations with narrow shoulders.

Based on the information contained in this report, the following recommendations are made:

- AFADs are recommended for use on two-lane roads.
- Additional training sessions and continued field use of AFADs are needed to increase usage throughout the state.
- Locate funding sources to purchase more units
- Complete additional research to determine if mobile operations are possible.

Chapter 1
Introduction

1.1 Background

Flagging operations are a critical part of construction and maintenance activities on our highways. Flagging personnel are trained to effectively and safely communicate the location of construction or maintenance activities to the traveling public. Due to the nature of the work, flagging personnel are located on the roadway near the work zone, which can result in dangerous situations. With the increasing levels of distracted drivers, safety of flaggers and workers in work zones is an increasing concern. Unfortunately, flagging personnel deaths and near misses continue to occur on our highways during each construction season.

1.2 Project Description

Automatic Flagger Assistance Devices (AFADs) are portable traffic control devices used by flagging personnel instead of traditional flagging equipment. The Minnesota Department of Transportation (MnDOT) Research Services section purchased three sets of AFADs for district use. The objective of this research project was to explore the use of the equipment and demonstrate utility. Research shows that it is safer to pull flagger personnel out of traffic using these devices. However, based on conversations with MnDOT personnel, there has been resistance in the past using these devices on a regular basis.

1.3 Project Overview

This project included the following tasks:

a) Review past AFAD use within MnDOT
b) Attendance at AFAD training sessions
c) Documentation of traditional flagging operations and AFAD flagging operations
d) Discussions with MnDOT work crews regarding AFAD operations
e) Development of recommendations regarding AFAD use

Each of these items is described in detail in the following report chapters.

Chapter 2
AFAD Equipment

The MnDOT Research Services section purchased three sets of AFADs for district use. AFADs manufactured by Safety Technologies, Inc., located in Red Wing, MN were used in this project. The following AFADs were purchased:

- Two (2) Sets of AutoFlagger AF-76 Remote Control Flagging Devices
- One (1) Set of AutoFlagger AF-54 Remote Control Flagging Devices

A brief description of each device is shown below. Additional information on each device is available at http://www.autoflagger.com.

2.1 AutoFlagger AF-76 Remote Control Flagging Device

The AutoFlagger AF-76 consists of two radio-controlled trailer-mounted devices, each selectively displaying either a STOP or SLOW retroreflective road sign. One red beacon and one flashing red strobe are displayed to motorists viewing a STOP sign. Two amber flashing strobes are displayed when the SLOW sign is displayed to motorists. Each sign unit also displays a retroreflective WAIT ON STOP, GO ON SLOW sign. A gate arm on each unit simultaneously blocks the lane of traffic it controls when the STOP message is displayed.

Figure 2.1 AF-76

2.2 AutoFlagger AF-54 Remote Control Flagging Device

The AutoFlagger AF-54 consists of two radio-controlled trailer-mounted devices, each selectively displaying either a RED or YELLOW LED traffic signal indication. Each sign unit also displays a retroreflective STOP HERE ON RED sign. A gate arm on each unit simultaneously blocks the lane of traffic it controls when the STOP message is displayed.

Figure 2.2 AF-54

Chapter 3
Review of Past AFAD Use

MnDOT started using AutoFlagger devices on an experimental basis in 1996. Use of the AutoFlagger devices was documented in a report titled *AUTOFLAGGER Research Project* dated February, 2005. The report states that the AutoFlagger devices were used throughout the state with considerable success and positive responses from work crews and the traveling public.

Since this original AutoFlagger implementation, use of the devices has slowly diminished. In order to understand why, MnDOT and County personnel were contacted to discuss the AutoFlagger operations and experiences. The following responses were recorded:

- *Stearns County, MN Maintenance Supervisor* - Currently use AutoFlagger in rural, low volume locations. Has worked well on stationary projects. Have had some issues with sign turning operations, but manufacturer has repaired any issues. Typically the unit is parked in the lane with cones defining the approach lane and stopping locations.

- *MnDOT District 6 – Rochester, MN* - Currently have one set of AutoFlaggers that are around 10 years old. Use them 2-3 times per year. Works well for 6-8 hour projects such as bridge maintenance. They can move the units in tandem. Easier to use traditional flagging operations for shorter projects. Limitations on locations due to maximum 1,500 ADT requirement.

- *MnDOT District 1 – Duluth, MN* - Currently have one set of AutoFlaggers. Use them on two lane road projects. They do not get much use. Contractor has proposed using them on projects within the district. Easier to use traditional flagging operations for shorter projects.

- *St. Louis County, MN Maintenance Supervisor* - Currently have one set of AutoFlaggers. Overall pleased with operations. Use them on two lane road projects. They do not get much use.

- *Mike Kowski, MnDOT Metro District – Roseville, MN* - MnDOT starting researching AutoFlagger use in the early 1990's. MnDOT used a set of AutoFlaggers throughout the state, including the Metro district, District 6, and a City project in St. Paul. The research included a survey form handed out to motorists stopped. Overall the response was positive. However, the Federal Highway Administration would not approve the devices since flagging operations needed to include a person operating the flagging paddle. Since that time the devices have been approved.

Overall, use of the AutoFlagger devices was viewed as positive. However, the additional effort needed to setup and take down the devices was viewed as negative, leading to the use of traditional flagging operations in many instances.

Chapter 4
AFAD Training Sessions

Two training sessions were held to introduce the AFADs to MnDOT personnel. A description of each session is shown below.

4.1 Training Session #1

Location: MnDOT Office and Training Center in St. Cloud, MN
Date: September 12, 2013

Training session #1 was attended by 26 people, including 24 MnDOT employees from Districts 3 and 8. The session agenda included the following:

1. Presentation on the AutoFlagger by Dave Jones from Safety Technologies, Inc.

2. Hands on viewing of the AutoFlagger devices in the equipment yard.

3. Demonstration of the AutoFlagger devices in the equipment yard.

4. Discussion of initial impressions, perceived limitations, and next steps.

This session resulted in an initial introduction of the devices to MnDOT personnel. Actual usage of the devices occurred after completion of this session.

Photos from Training Session #1 are shown below:

Figure 4.1 AF-54 in Tandem

Figure 4.2 AF-54 Operating in Maintenance Yard

Figure 4.3 AF-76 in Tandem

Figure 4.4 AF-76 Operating in Maintenance Yard

4.2 Training Session #2

Location: MnROAD Research Facility in Monticello, MN
Date: October 25, 2013

Training session #2 was attended by 35 people, including 33 MnDOT employees from Districts 3, 8, and Metro. The session agenda included the following:

1. Introduction and sign in sheet

2. Slide presentation - device setup
    a. AutoFlagger setup
    b. Work zone setup (shown in Figure 4.9)

3. Slide presentation - device operation

4. Visual presentation of device operation
    a. Show how devices operate using remote control
    b. Control devices from inside the classroom

5. Hands on operations outside
    a. Move devices to test locations on low volume road
    b. Split into groups of 4-6
    c. Each group completes all setup and operations steps
    d. Other class members drive vehicles through the work zone while the devices are operating

6. Wrap up discussion in classroom
    a. How to use in mobile operations
    b. Can current mobile flagger operations be modified to accommodate AutoFlagger
    c. Potential issues
    d. Ideas for improvement
    e. Other discussion

This session included detailed operation of the AF-76 device. MnDOT personnel were able to setup and operate the devices in a controlled environment with actual vehicle traffic. Additional field use of the devices occurred after the completion of this session.

Photos from Training session #2 are shown below:

Figure 4.5 AF-76 Towed to Test Site at MnROAD

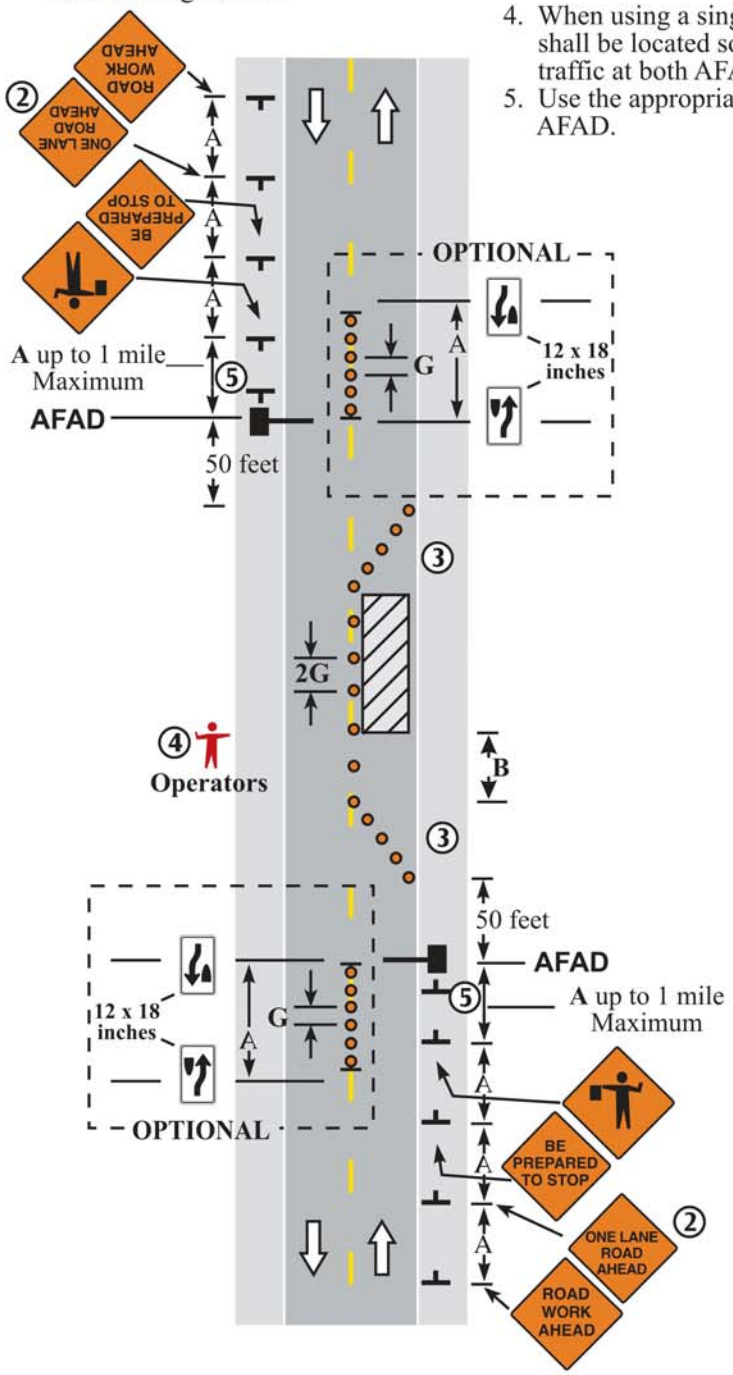
Figure 4.6 AF-76 Being Setup at Test Site

Figure 4.7 Vehicles Traveling Past AF-76 at Test Site

Figure 4.8 Vehicles Traveling on MnROAD Test Track

NOTES:

1. The approach sight distance to the Automated Flagging Assistance Device (AFAD) shall be at least the Decision Sight Distance (D).
2. The ONE LANE AHEAD sign may be omitted when the posted speed limit is 40 mph or less.
3. The two-way taper should be 50 feet in length using 5 equally spaced channelizing devices.
4. When using a single operator, they shall be located so they can to see traffic at both AFAD locations.
5. Use the appropriate sign on the AFAD.



LANE CLOSURE, AUTOMATED FLAGGERS
TWO-LANE TWO-WAY ROAD

3 DAYS or LESS LAYOUT 12

Figure 4.9 AFAD Layout from MnDOT Field Manual

Chapter 5
Field Documentation of Flagging Operations

Field operations for various flagging operations were observed and documented. Operations utilizing both traditional flagging and AFADs were included in the documentation phase. Major points included in the documentation were:

- Observe each flagging operation in the field to document the procedures used during setup, field operation, and take down.
- Document the amount of time needed for each operation.
- Place major emphasis on the AFAD operation and maintenance, including safety benefits, operational issues, ease of use, hindrance of usage, effectiveness of the devices, driver reactions, etc.

5.1 Traditional Flagging Operations

5.1.1 Stationary Operations

A stationary traditional flagging operation was observed on December 13, 2013. The flagging operation took place on T.H. 25 approximately 2 miles south of Montrose, MN. MnDOT maintenance personnel were repairing a guard rail assembly, required the closure of the northbound lane. The work zone was approximately 1,000 feet in length.

The flagging operation required two people operating flagging paddles and communicating via hand held radios. The operation required approximately 20 minutes for setup, including placement of the advance signs. Take down required approximately 20 minutes to complete.

Overall the operation was effective for the required lane closure. Motorists understood the situation and followed the direction for the flaggers. Under this setup, the flagging personnel are located on the shoulder of the roadway the entire time. This exposes them to the weather conditions and places them close to passing vehicles.

Photos from this operation are shown below.

Figure 5.1 Advance Signing Setup

Figure 5.2 Vehicles Waiting at Stop Sign

Figure 5.3 Traditional Flagging Operation

Figure 5.4 View of Work Zone

5.1.2 Mobile Operations

A mobile traditional flagging operation was observed on September 26, 2013. The flagging operation took place on T.H. 71 approximately 3 miles south of Redwood Falls, MN. MnDOT maintenance personnel were performing crack repair operations, requiring closure of the southbound lane. The flagging operation required two people operating flagging paddles and communicating via hand held radios. The operation required approximately 20 minutes for setup, including placement of the advance signs. Take down required approximately 20 minutes to complete.

Overall the operation was effective for the required lane closure. The flagging operation moved continuously due to the nature of the crack sealing work. Motorists understood the situation and followed the direction for the flaggers. Under this setup, the flagging personnel are required to be located on the shoulder of the roadway the entire time. This exposes them to the weather conditions and places them close to passing vehicles.

Photos from this operation are shown below.

Figure 5.5 View of Work Zone

Figure 5.6 Vehicles Stopped at Flagger

Figure 5.7 Vehicle Approaching Flagger

Figure 5.8 View of Work Zone

Figure 5.9 Vehicles Traveling Through Work Zone

5.2 AFAD Operations

5.2.1 Stationary Operations with AF-76

A stationary AFAD flagging operation using the AF-76 was observed on October 16, 2013. The flagging operation took place on T.H. 25 approximately 2 miles south of Montrose, MN. MnDOT maintenance personnel were cleaning a drainage area and culvert, required the closure of the northbound lane. The work zone was approximately 1,600 feet in length.

The flagging operation required one person operating both AFAD devices. The operation required approximately 40 minutes for setup, including placement of the advance signs. Take down required approximately 40 minutes to complete.

Overall the operation was effective for the required lane closure. Motorists understood the situation and followed the direction for the AFAD devices. Under this setup, the flagging personnel are able to remain in a pickup truck located within the work zone. This removes them from weather conditions and passing vehicles.

Photos from this operation are shown below.

Figure 5.10 Approach to AF-76

Figure 5.11 Vehicles Stopped at AF-76

Figure 5.12 Vehicle Preparing to Leave AF-76 Location

Figure 5.13 View From Operator Location Inside Truck

Figure 5.14 View From Operator Location

5.2.2 Stationary Operations with AF-54

A stationary AFAD flagging operation using the AF-54 was observed on July 30, 2014. The flagging operation took place on T.H. 25 immediately west of Watertown, MN. MnDOT maintenance personnel were cleaning a drainage area and culvert, which required the closure of the westbound lane. The work zone was approximately 1,000 feet in length.

The flagging operation required one person operating both AFAD devices. The operation required approximately 40 minutes for setup, including placement of the advance signs. Take down required approximately 40 minutes to complete.

Overall the operation was effective for the required lane closure. Motorists understood the situation and followed the direction for the AFAD devices. Under this setup, the flagging personnel are able to remain in a pickup truck located within the work zone. This removes them from weather conditions and passing vehicles.

Photos from this operation are shown below.

Figure 5.15 View of Work Zone

Figure 5.16 Approach to AF-54

Figure 5.17 View of Operator Location

Figure 5.18 Vehicle Stopped at AF-54

Figure 5.19 Vehicles Leaving AF-54

Chapter 6
Work Crew Interviews

MnDOT maintenance personnel were interviewed to learn about experiences with traditional and AFAD flagging operations. The following comments were noted:

Traditional Flagging Operations:

- Driver inattention is a big issue. Driver cell phone use leads to many close calls.
- Has witnessed two close calls during flagging operations. Both resulted in serious rear end crashes.

AFADs

- AutoFlagger is much more visible that traditional flagging operations
- Need to figure out how to use AFADs for mobile operations. Could possibly use three units, with two in front leap frogging each other to keep operations mobile.
- Works well for stationary projects
- Will drivers stop if no one is standing near the unit?
- Can one person operate both AFAD devices at the same time?
- If we need two people to operate the AFADs, will probably use traditional flagging instead
- More lights are needed on the arm for increased visibility
- Cones are needed to help direct drivers
- How will they work in winter conditions?
- Currently use four people for flagging operations, accounting for breaks and time limits. That number could be reduced to two at locations where one operator controls both AFADs.

Chapter 7
Conclusions and Recommendations

Based on the observations and interviews described in this report, the following conclusions were made:

- AFADs work well on two-lane roads.
- One set of AFADs can be operated by one person under certain conditions.
- Worst-case scenario requires two people to operate one AFAD set. Personnel are removed from traffic while operating.
- Setup and take down require more effort than traditional flagging but are still considered reasonable.
- More research is needed to determine if mobile operations are possible.
- Overall the AFADs were very popular with maintenance staff.
- The AF-76 is preferred at locations with wide shoulders. The AF-54 works well at locations with narrow shoulders.

Based on the information contained in this report, the following recommendations are made:

- AFADs are recommended for use on two-lane roads.
- Additional training sessions and continued field use of AFADs are needed to increase usage throughout the state.
- Locate funding sources to purchase more units
- Complete additional research to determine if mobile operations are possible.

References

Minnesota Department of Transportation, *AUTOFLAGGER Research Project* (St. Paul, MN: Minnesota Department of Transportation, February 2005), 1-6

Minnesota Department of Transportation, *Mobile Traffic Signals in Lieu of Flaggers for Moving Operations*, (St. Paul, MN: Minnesota Department of Transportation and CTC & Associates, June 2013), 1-7

Minnesota Department of Transportation, *Temporary Traffic Control Zone Layouts Field Manual*, (St. Paul, MN: Minnesota Department of Transportation, January 2014), Layout 12

Safety Technologies, Inc. (Internet), AF-54 model, (cited December 2013), http://www.autoflagger.com/AF-54.html

Safety Technologies, Inc. (Internet), AF-76 model, (cited December 2013), http://www.autoflagger.com/AF-76.html