E - CONTROL OF TRAFFIC THROUGH WORK AREAS

E-1 Function

The primary function of traffic control procedures is to move traffic safely and expeditiously through or around work areas.

The control of traffic through work areas is an essential part of highway construction, maintenance and utility operations. For these operations, there must be adequate authority for the implementation and enforcement of needed traffic regulations, parking controls and speed zoning. Such authority must provide sufficient flexibility in the application of traffic control to meet the needs of the changing conditions in work areas.

E-2 Hand Signaling Devices

A number of hand signaling devices, such as stop/slow paddles, lights and red flags are used in controlling traffic through work zone. The sign paddle bearing the clear message stop or slow provides motorists with more positive guidance than flags and should be the primary hand signaling device. Flags used shall be limited to emergency situations.

Sign paddles shall be octagonal in shape and at least 24 inches wide, with a minimum of 6 inch series C letters. It is recommended that 8 inch series C letters be used for the "STOP" side and 8 inch series B letters be used for the "SLOW" side. These dimensions will be required after January 1, 2000. A rigid handle shall be provided such that the bottom of sign paddle will be 6' above ground. This combination sign may be fabricated from sheet metal or other light semi-rigid material. The background of the STOP face shall be red with white letters and border. The background of the SLOW shall be orange with black letters and border. The STOP face shall be reflectorized red with white reflectorized letters and border, and the SLOW face shall be reflectorized orange with black letters and border. The reflective sheeting used for both faces shall meet the specifications in B-1 for "Hi Intensity".

Flags shall be used only in emergency situations or within an intersection while the intersection remains under signalized control. In the intersection case the flagger is only directing traffic around an obstruction while the signal provides actual control. If the flagger is controlling the intersection, the signal shall be on flash or dark, and each approach shall be controlled by a flagger using the STOP/SLOW paddle.

Flags used for signaling purposes shall be a minimum of 24 by 24 inches in size, made of a good grade of red material securely fastened to a staff approximately 3 feet in length. The free edge should be weighted to insure that the flag will hang vertically, even in heavy winds.

When a sign paddle is used, it shall be held in a stationary position with the arm extended horizontally away from the body.

Except in emergency situations, flood lights shall be used to illuminate flagger stations during night time operations.

Whenever practicable, the flagger should advise the motorist of the reason for the delay and the approximate period that traffic will be halted. Flaggers and operators of construction, maintenance or utility machinery or trucks should be made to understand that every reasonable effort must be made to allow the driving public the right of way and prevent excessive delays.

E-3 Flaggers

Since flaggers are responsible for human safety and make the greatest number of public contacts of all construction, utility and maintenance personnel, it is important that qualified personnel be selected. A flagger shall posses the following qualifications:

A. Average intelligence
B. Good physical condition, including sight and hearing
C. Mental alertness
D. Courteous, but firm manner
E. Neat appearance
F. Sense of responsibility for safety of public and crew

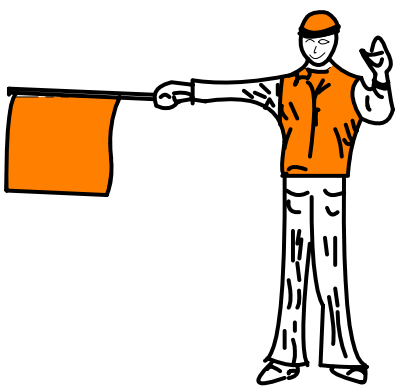
Personnel working as flaggers shall wear orange colored clothing on the upper portion of the body, or an approved vest. Flaggers shall wear the appropriate orange colored head gear at all times. For nighttime conditions similar outside garments shall be reflectorized.

Flaggers are provided at worksites to stop traffic intermittently as necessitated by work progress or to maintain continuous traffic past a worksite at reduced speeds to help protect the work crew. For both of these functions the flagger must, at all times, be clearly visible to approaching traffic for a distance sufficient to permit instructions, and to permit traffic to reduce speed before entering the worksite. In positioning flaggers, consideration must be given to maintaining color contrast between the work area background and the flaggers protective garments.

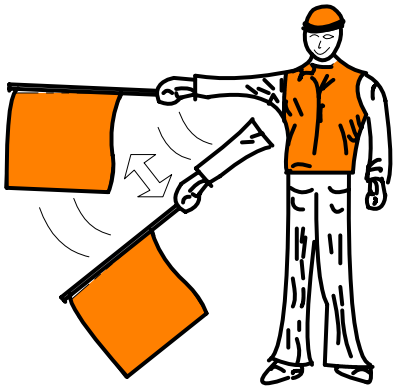
Individuals working as flaggers shall be properly and modestly attired for a work site. The absence of attire or the wearing of abbreviated or suggestive attire, including shorts above the knee and halter tops or attire which is subject so as to create a danger or inadvertent snagging by vehicles and/or equipment is prohibited. As a minimum, the flagger shall wear a T-Shirt with short sleeves and long pants down to the ankles.

The flagger shall not:

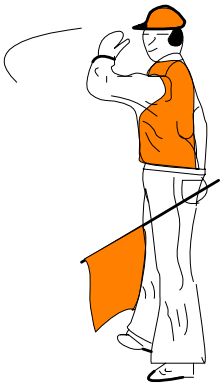
A. Mingle with the crew when work is being performed
B. Leave his/her post unless authorized to do so
C. Turn his/her back on approaching traffic
D. Sit or stand in the shade or stand in front of equipment while on duty



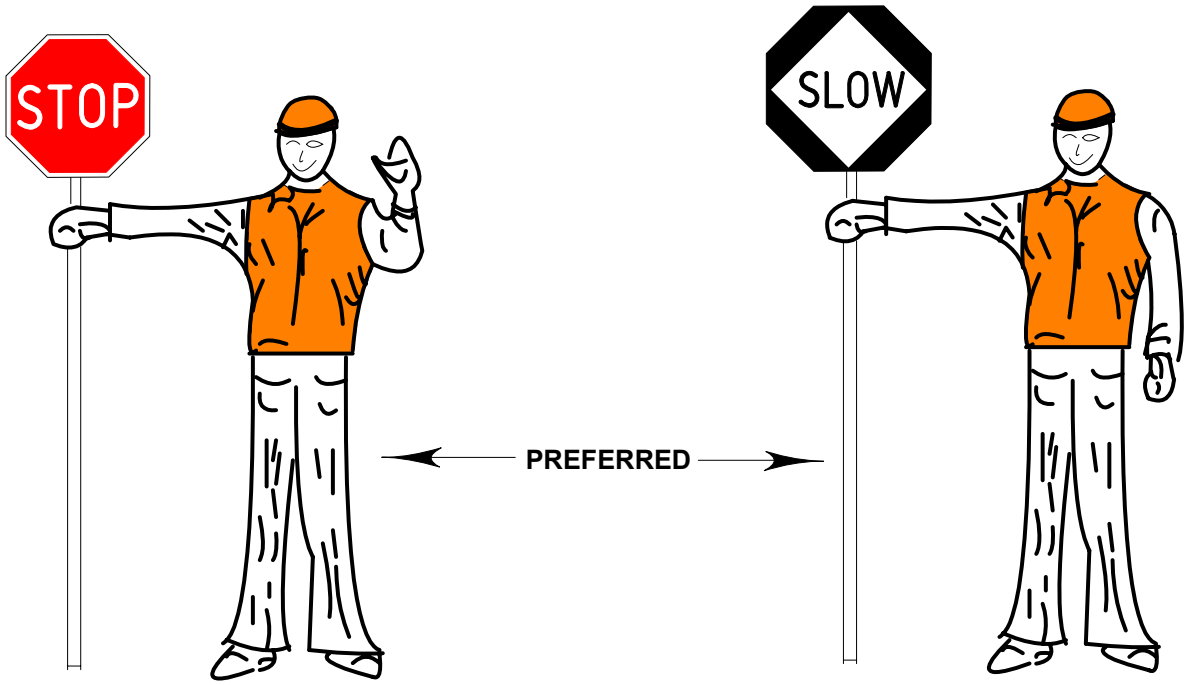
TO STOP TRAFFIC



TO ALERT AND SLOW TRAFFIC



TRAFFIC TO PROCEED



TO STOP TRAFFIC

TO ALERT AND SLOW TRAFFIC

E-4 Flagging Procedures

The following methods of signaling with a Stop/Slow paddle or flag shall be used:

A. To Stop Traffic

The flagger shall face traffic and extend the STOP sign paddle in a stationary position with the arm extended horizontally away from the body. The free arm is raised with the palm toward approaching traffic.

The flagger shall face traffic and extend the flag horizontally across the traffic lane in a stationary position so that the full area of the flag is visible hanging below the staff. For greater emphasis the free arm may be raised with the palm toward approaching traffic.

B. When is it Safe for Traffic to Proceed

The flagger shall face traffic with the SLOW sign paddle held in a stationary position with the arm extended horizontally away from the body. The flagger motions traffic ahead with the free hand.

The flagger shall stand parallel to the traffic movement, and, with flag arm lowered from view of the driver, motion traffic ahead with a free arm. Flags shall not be used to signal traffic to proceed.

C. Where is it Desired to Alert or Slow Traffic

The flagger shall face traffic with the SLOW sign paddle held in a stationary position with the arm extended horizontally away from the body.

The flagger shall face traffic and wave the flag in a sweeping motion shall be for alerting drivers to be prepared for further instructions including the need to slow or stop.

E-5 Flagger Stations

There are two basic types of flag stations - approach speed control and intersection control. Approach speed control stations shall be located far enough in advance of the work site so that approaching traffic will have sufficient distance to reduce speed before entering the project. This distance is related to approach speed and physical conditions at the site; however, 500 feet is desirable. In urban areas when speeds are low and streets closely spaced the distance necessarily must be decreased.

The flagger should stand either on the shoulder adjacent to the traffic being controlled or in the barricaded lane. A "spot" obstruction, the flagger may have to stand on the shoulder opposite the barricaded section to operate effectively. Under no circumstances shall a flagger stand in the lane being used by moving traffic. The flagger shall be clearly visible to approaching traffic at all times. For this reason, the flagger must stand alone, never permitting a group of workmen to congregate around. The flagger shall be stationed sufficiently in advance of the work force to warn them of approaching danger such as out of control vehicles.

For intersection control the flagger should stand either on the shoulder adjacent to the traffic being controlled or in the barricaded lane. Once traffic has stopped, it may be necessary to move into the stopped lane so as to adequately control conflicting traffic. The flagger shall be clearly visible to the moving traffic lane. For this reason, the flagger must stand alone, never permitting a group of workmen to congregate around.

Flag stations must be adequately protected and shall be preceded by proper advance warning signs. At night, flag stations shall be adequately illuminated with either light plants or other roadway lighting of 400 watt HPS or greater centered at the flagger station.

When flagging operations are in the proximity of a railroad crossing where queue lengths may extend over the crossing, an additional flagging station shall be placed at the crossing to ensure that the queue does not stop on the tracks.

E-6 One Way Traffic Control

Where traffic in both directions must, for a limited distance, use a single lane, provision should be made for alternate one-way movement to pass traffic through the constricted section. At a "spot" obstruction, such as an isolated pavement patch, the movement may be self-regulated. However, where the one lane section is of any length, there should be some means of coordinating movements at each end so that vehicles are not simultaneously moving in opposite directions in the section so that delays are not excessive at either end. Control points at each end of the route should be chosen so as to permit easy passing of opposing lines of vehicles.

E-7 Flagger Control

Where the one lane section is short enough so that each end is visible from the other end, traffic may be controlled by means of a flagger at each end of the section. One of the two should be designated as the chief flagger for purposes of coordinating movement. They should be able to communicate with each other verbally or by means of signals. These signals should not be such as to be mistaken for flagging signals.

Where the end of a one lane section is not visible from the other end, the flagger may maintain contact by means of radio or field telephones. So that a flagger may know when to allow traffic to proceed into the section, the last vehicle from the opposite direction can be identified by description or license.

E-8 Flag Carrying or Official Car

Flag carrying is effective when the route is well defined and non-hazardous. It should be employed only when the one way traffic is confined to a relatively short stretch of road, usually not more than one mile in length.

The driver of the last vehicle proceeding into the one lane section is given a red flag (or other token) and instructed to deliver it to the flagger at the other end. The opposite flagger, upon receipt of the flag, then knows that it is safe to allow traffic to move in the other direction. The flag being carried should always be clean and dry.

A variation of this method is the use of an "official" car which always follows the last vehicle proceeding through the section. The use of an official car eliminates the possibility of loss of the flag.

E-9 Pilot Car

The use of a pilot car for traffic control can be most effective where the route is particularly hazardous, or so involved or frequently altered as to preclude adequate signing. The pilot car is used to guide a train of vehicles through the job or detour. Its operation must be coordinated with flagging operations or other controls at each end of the one lane section. Sufficient turn around room should be provided at these points. Provisions should be made for identification of the last vehicle in the column. The Pilot Car sign shall be mounted on the rear of the vehicle.

E-10 Traffic Signs

Where the one lane section is short enough so that each end is visible from the other end, traffic may be controlled by means of signs at each end of the section. Typical special signing situations are illustrated in this manual.

E-11 Pavement Markings

Definitions

1. LANE LINE: Lines of marking material placed between lanes of traffic moving in the same direction.

2. EDGE LINE: Lines of marking material placed on the right-hand side of a travel lane with two way traffic and on both sides of a traveled way having one way traffic.

3. CENTER LINE: Lines of marking material placed between lanes of traffic traveling in opposite directions.

4. NO PASSING ZONES: Roadway sections where passing to the left is prohibited by a pattern of pavement markings.

5. DETOUR MARKINGS: Markings which are placed to cause or require traffic to move from the normal or previous travel path. ALL DETOUR MARKINGS SHALL BE INSTALLED USING STANDARD MARKING PATTERNS.

6. STANDARD MARKING PATTERNS: Complete marking sets as required for the complete marking of roadways in the MUTCD.

7. TEMPORARY MARKINGS: Marking patterns which are abbreviated in nature due to the short time they are allowed in service.

8. INTERMEDIATE MARKINGS: Standard marking patterns which are placed on sublifts of paving materials or on final travel surfaces, but which are not the final markings. Intermediate markings include all centerlines, edgelines, stop bars, arrows, lane lines, etc. (Edgelines are not required unless the markings will be in place more than 28 calendar days or over the winter, or if directed by the Engineer).

9. FINAL MARKINGS: Standard marking patterns which are placed on the final travel surface. These markings are to be placed using approved materials. Final markings shall always be applied in accordance with the Manual of Uniform Traffic Controls.

A. Existing Pavement Markings: When long term work necessitates vehicle paths other than in the lanes normally indicated by existing pavement markings, checks should be made to evaluate the possibility that the pavement markings will not inadvertently lead drivers into barricades and/or work sites. Where necessary, these markings should be obliterated or removed. Painting over existing pavement markings does not meet the requirements for obliteration or removal. Approved removable masking tape may be used to temporarily obliterate existing pavement markings.

B. Application at Work Areas

Proper and consistent pavement markings are important to the driver, as he places a high priority on what he sees on the pavement. Centerline, lane and edgeline markings provide excellent path guidance, which is of particular importance in tapers, crossovers and runarounds. Edgelines used to supplement channelizing devices will continue to function, even if the devices have been knocked down.

C. Specification for Removable Preformed Retroflective Pavement Marking for Construction, Maintenance, and Utility Work Zones

(1) General

This specification is for markings which must be readily removed when they are no longer applicable. They shall be capable of performing for the duration of a normal construction season and shall then be capable of being removed intact or in large pieces either manually or with a recommended roll up device.

The preformed markings shall consist of white or yellow reflectorized film on a conformable backing.

The size, quality, and refractive index of the glass beads shall be such that the performance requirements for the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.

The pigments shall be selected and blended to provide pavement markings which are white or yellow, conforming to standard highway colors.

The markings shall be precoated with a pressure sensitive adhesive and shall be capable of being adhered to asphalt, concrete, or Portland cement concrete in accordance with manufacturer's instructions without the use of heat, solvents, or other additional adhesive means, and shall be immediately ready for traffic after application.

The markings shall be provided in specified shapes and widths. Performed words and symbols shall conform to the applicable shapes and sizes as outlined in the, "Delaware Manual on Uniform Traffic Control Devices for Street and Highways".

The materials shall be packaged in accordance with accepted commercial standards and when stored in a cool dry area indoors, shall be suitable for use for one year after date of purchase.

(2) Requirements

Composition: The removable preformed pavement marking film shall consist of a mixture of high quality polymeric materials, pigments, and glass beads, with a reflective layer of beads bonded to the top surface.

Reflectance: The white and yellow films shall have the following initial minimum reflectance values at 0.2o and 0.5o observation angles and 86.0o entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard 370. The photometric quantity to be measured shall be specific luminance (SL)*, and shall be expressed as millicandelas per square foot per foot candle (mod.ft-2).fc-1). The metric equivalent shall be expressed as millicandelas per square meter per lux. The test distance shall be 50 ft. (15m) and the sample size shall be a 2.0 x 2.5 ft. rectangle (0.61x0.76 m).

The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample, and the reference axis shall be taken perpendicular to the test sample.

	White		Yellow	
Observation Angle	0.2o	0.5o	0.2o	0.5o
SL (mod.ft-2).fc-1)	1770	1270	1310	820

"The quantity SL (specific luminance) treats the retroflector as a surface source (rather than a point source) whose projected area is visible as an area at the observation position. The quantity SL related to the way the effective retroreflective surface is focused on the retina of the human eye and to the visual effect thereby produced. It is recommended for describing the performance of highway signs and striping, or large vehicular markings which are commonly viewed as discernible surface areas". Federal Test Method Standard 370, 3.1.2, Note 6. March 1, 1977.

Adhesion: The manufacturer shall be required to demonstrate that the properly applied pavement marking adheres to the roadway under climatic and traffic conditions normally encountered in the construction work zone.

Removability: The marking film shall be removable from asphalt and Portland cement concrete intact or in large pieces, either manually or with a roll-up device, at temperatures above 40F (4oC) without use of head, solvents, grinding, or blasting. The manufacturer shall certify that the marking film has met this requirement after traffic exposure based on transverse test decks with rolling traffic.

Skid Resistance: The surface of the marking film shall provide an initial minimum skid resistance value of 50 BPN when tested according to ASTM E303-74.

D. Temporary Markings

Temporary Markings are an abbreviated pattern of pavement markings which may be warranted for short term use as specified below. They are appropriate only when both the scheduled and actual period of use are within the time specified. Upon a determination that such use period will extend, or has extended beyond the specific period, standard markings shall immediately be installed, as applicable to the then existing traffic situation.

Temporary Markings may be installed using paint, tape or individual reflector units (raised pavement markers, or RPM's).

E. Marking Installation

(1) General

All inappropriate existing pavement markings shall be removed and lane markings and center markings of the type required shall be in place before the work day ends. Whenever the work day is interrupted by weather, markings shall be made as complete as possible. They shall be completed as soon as possible thereafter including weekend or holiday work if necessary.

All markings shall be fully reflectorized. They shall be replaced as necessary to maintain acceptable levels of daytime and nighttime reflectivity.

All marking materials shall be installed in accordance with the manufacturer's recommendation using equipment designed for this purpose. The equipment shall be designed and constructed to satisfy the requirements of the National Board of Fire Underwriters and appropriate state laws, including those of size and weight restrictions.

The markings shall be protected until track-free by placing guarding or warning devices as necessary. In the event any vehicle should cross the markings before track-free, such marking shall be reapplied and any markings made by the moving vehicle shall be removed.

The markings shall be installed in a pattern and color that matches the pattern which existed prior to the start of the work or as directed by the Engineer.

The materials to be used must be approved by the Department prior to installation.

(2) Centerline

a. AADT up to 1000 vehicles per day with an operational duration of three or less calendar days-Temporary Marking consisting of a 4 foot stripe on 40 foot center is permitted. Roadways with severe curvature may warrant the use of standard markings or a 2 foot stripe on 20 foot centers.

b. AADT greater than 1000 vehicle per day or duration of four or more calendar days-Intermediate Markings consisting of a 10 foot stripe on 40 foot center is permitted.

c. No passing zones shall be solid yellow stripes as specified by the MUTCD, except that where Temporary Markings are permitted, no passing zones may be identified by signs if permitted by the Engineer, but not longer than 3 days in any case.

(3) Lane Line

a. AADT up to 1000 vehicles per day with duration of three or less calendar days - 4 foot stripe on 40 foot center permitted.

b. AADT greater than 1000 vehicles per day or with an operational duration of four or more calendar days - Intermediate Markings consisting of a 10 foot stripe on 40 foot center is permitted.

(4) Edge Line

a. Edge Line markings, when used, shall be solid stripe.

b. Unless specifically set forth in the plans, or directed by the Engineer, edgelines are not required.

(5) Raised Pavement Markers (RPM's)

a. A combination Raised Pavement Marker (RPM)/ stripe system is permitted for left edge line on multi-lane roads. RPMs or combination RPM/ stripe shall not be used for right edge line markings. They may be used when it is obvious to the motorists that such markings are for delineation and are not intended to mark a lane line. Examples include: ramps, gores, bifurcations, narrow bridges, detours, or at spot hazards. When used with edge line stripes, RPMs should be placed on the traffic side of the edge line stripe.

b. RPMs having self-adhesive (or other) backing may be used in lieu of or to supplement other pavement markings.

1. When RPMs are used to simulate a line, spacing is as follows:

(a) Broken Line-Four reflective RPMs on 3 1/3 foot centers with a 30 foot gap (or equal).

(b) Solid Line - Reflective RPMs on 5 foot centers. However, up to a 10 foot spacing may be acceptable if approved by the Engineer.

(c) Double Solid Line - Same pattern as solid line except two lines 3 to 4 inches apart.

Note: When RPMs are used to simulate a line they must be visible both day and night.

2. Where RPMs are used to supplement a line, recommended spacing is as follows:

(a) Broken Lines - Reflective RPMs at center of gap.

(b) Solid Line - Reflective RPMs on 40 foot centers 2 to 3 inches to the side of the stripe supplemented.

(c) Double Solid Line - Same pattern as solid line except two lines of RPMs (outside striped lines - both sides). Recommended spacing on transitions, painted islands or medians, and curves 6o or more is 20 foot centers.

3. Listed below are guidelines for the use of temporary RPMs in Construction, Maintenance, or Utility Work Zones:

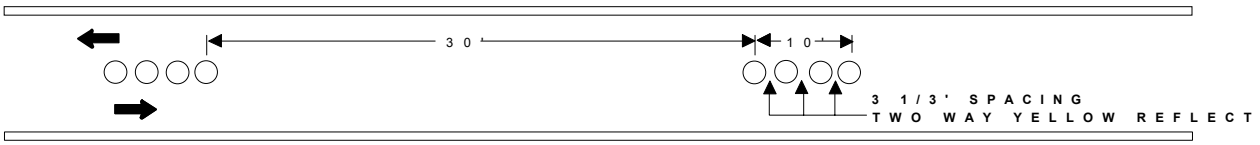
   (a) The RPMs shall not be used during the winter months, when there may be damage or removal by snow plow blades.

   (b) The RPMs shall not be used to indicate a no passing zone. A solid yellow line shall be used with the required signs.

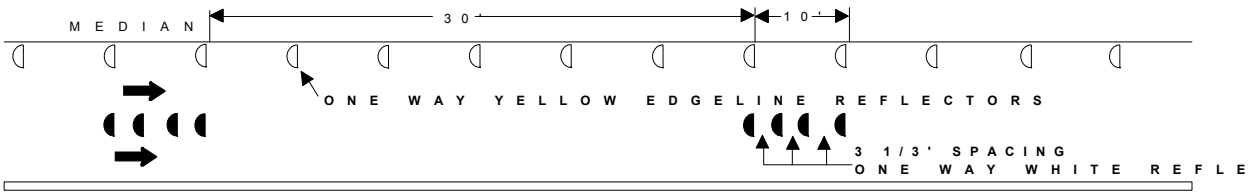
   (c) White RPMs shall not be used for edgelines.

STANDARD DESIGN
TYPICAL APPLICATION OF TRAFFIC CONTROL DEVICES
FOR
HIGHWAY CONSTRUCTION AND MAINTENANCE

RAISED PAVEMENT MARKERS
(CONSTRUCTION ZONES)



RPM SYSTEM (2 lane, 2 way)
PASSING ZONES ONLY



RPM SYSTEM (multi lane divided)

SYMBOLS		**SYMBOLS**
⬅	**Traffic Flow**	○ **2 Way Yellow RPM**
▭	**White Stripe**	◖ **1 Way Yellow RPM**
		◖ **1 Way White RPM**