NOAA Dispersant Mission Planner 2 (DMP2) Documentation

Introduction

This is the latest in a series of NOAA Dispersant Mission Planners. The purpose of the DMP2 is to estimate the performance of defined dispersant application systems, both aircraft and vessel platforms. The DMP2 does this in two modes. The first is the EDAC (Effective Daily Application Capacity) mode wherein the EDAC for each of the defined aircraft platforms is calculated using the same scenario. No EDAC calculation is performed by DMP2 for vessel platforms as standardized vessel platforms have not been defined. The EDAC scenario and assumptions are as follows:

- -The Dispersant-to-Oil Ratio (DOR) is 1:20.
- -Five gallons of dispersant will be applied to each acre (46.8 liters/hectare).
- -The oil slick to be treated is 4 nautical miles (7.4 km) long in the direction of spraying.
- -Aircraft platforms have 12 hours of time available for Tier 2 and Tier 3 dispersant operations, not including the last transit back to the primary dispersant staging site. For Tier 1, dispersant operations must commence at the site of a discharge within 7 hours of the Federal On-Scene Coordinator's decision to use dispersants.
- -Cascading of aircraft from out-of-area requires entries for the platform/dispersant mobilization time, cascade distance, and platform dispersant payload status (loaded or empty). Cascading aircraft have a 45 minute briefing at the primary dispersant staging site prior to commencing spraying operations. Cascading reduces the Utilization Time resulting in the use of Adjusted Utilization Time for DMP2 calculations.
- -Aircraft platforms will be allowed to apply dispersants in both directions.
- -Check-in time of 10 minutes with spotter aircraft occurs at the beginning of each sortie. Spotter aircraft are assumed on-scene waiting for dispersant spray aircraft.
- -Aircraft platforms will be allowed to refuel and load dispersants at the same time except for USAF Reserve C-130 H.
- -Transit distance for vessel response plans is measured from the primary dispersant staging site (or closest dispersant staging site for plans with multiple staging sites) to the furthest spill site 50 NM off shore within a Captain of the Port (COTP) zone.
- -Transit distance for facility response plans is measured from the primary dispersant staging site to the facility.
- -Weather:
  - Visibility greater than 3 statute miles (4.83 kilometers)*
  - Ceiling greater than 1000 feet (304.8 meters)*
  - No wind (0 mph)
  - No precipitation
  - Mild temperatures 40-80 degrees F (4.4 – 26.7 degrees Celsius)
  - *Visible Flight Rule (VFR) conditions are required at the spill site for aircraft to apply dispersants and are assumed for all flight operations, including cascading from home base to staging airports and for transit to

and from the spill site. VFR flight requires 30 minutes of fuel reserve on the aircraft.

The outcome of this mode is a single EDAC number for each defined aircraft platform/ dispersant staging site/COTP zone that response plan holders can use for determining compliance with regulatory requirements when they are published as final.

The second or variable mode of operation permits planners and operators to vary the characteristics of the supplied platforms (within limits) and also vary the one-way transit distance from the staging airfield to the location of the slick, the average pass length of the oil slick, and the utilization time (UT), the time available for the platform to operate in a day. In this mode, user-defined platforms can be added, edited, and deleted. A time adjustment for mobilization and cascading of platforms from out of area to the staging site can also be made.

The user interface for the DMP2 consists of several different layouts or pages including an introductory splash screen, an about screen, the Dosage Page, the Aircraft Calculation Page, the Vessel Calculation Page, and a record for each of the user-defined platforms. A Dispersant Aircraft Capability Form provides detailed specifications for pre-defined aircraft platforms.

Users can enter data into fields that have borders. Other selections are made from drop-down menus. The general flow within the DMP2 is:

1) Desired dosage specification based on dispersant to oil ratio (DOR) and concentration of the oil slick.
2) Platform selection. The DMP2 computes the pump rate necessary to match the desired dosage.
3) Specification of the oil slick (distance from staging site and average pass length) and utilization time.
4) Calculation of estimated performance.

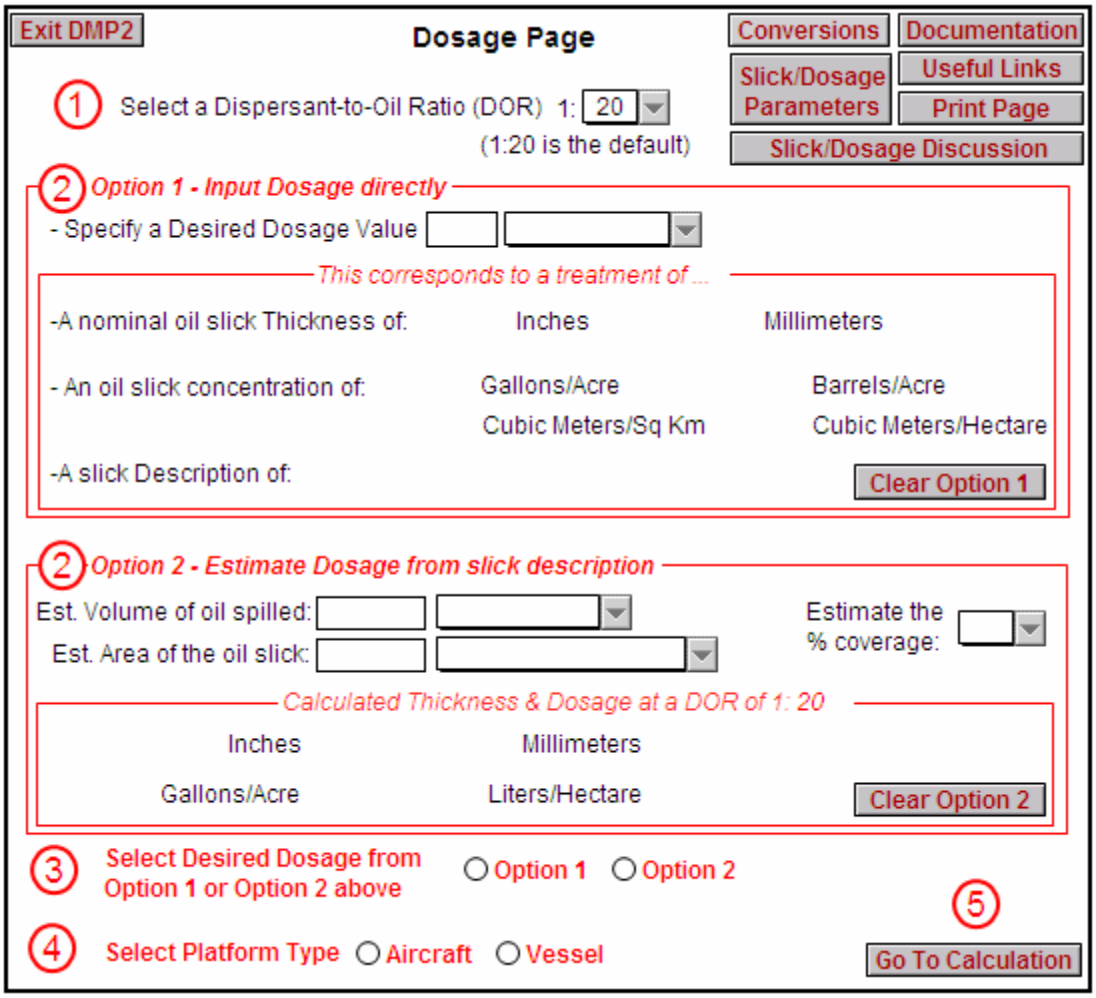
Dosage Page

The Dosage Page contains buttons to navigate to this DMP2 Documentation, Conversion factors, Useful Links, Slick/Dosage Parameters, and a Slick/Dosage Discussion which explores the Slick/Dosage Parameters and variability issues related to dosage selection and DMP2 computations. The Print Page button prints the Dosage Page.

A major problem with applying dispersants to oil slicks is that real world oil slicks are not uniform. For a given dosage, parts of the slick will most likely be under-dosed and parts will be over-dosed. The challenge then is to determine a nominal dosage that correctly treats the major part of the slick. One approach could be to make a dispersant application pass using the best estimate of dosage and observe effectiveness from the spotter aircraft and SMART monitoring. Subsequent dosages could be adjusted based on this monitoring.

In the variable mode on the DMP2 Dosage Page, the user:

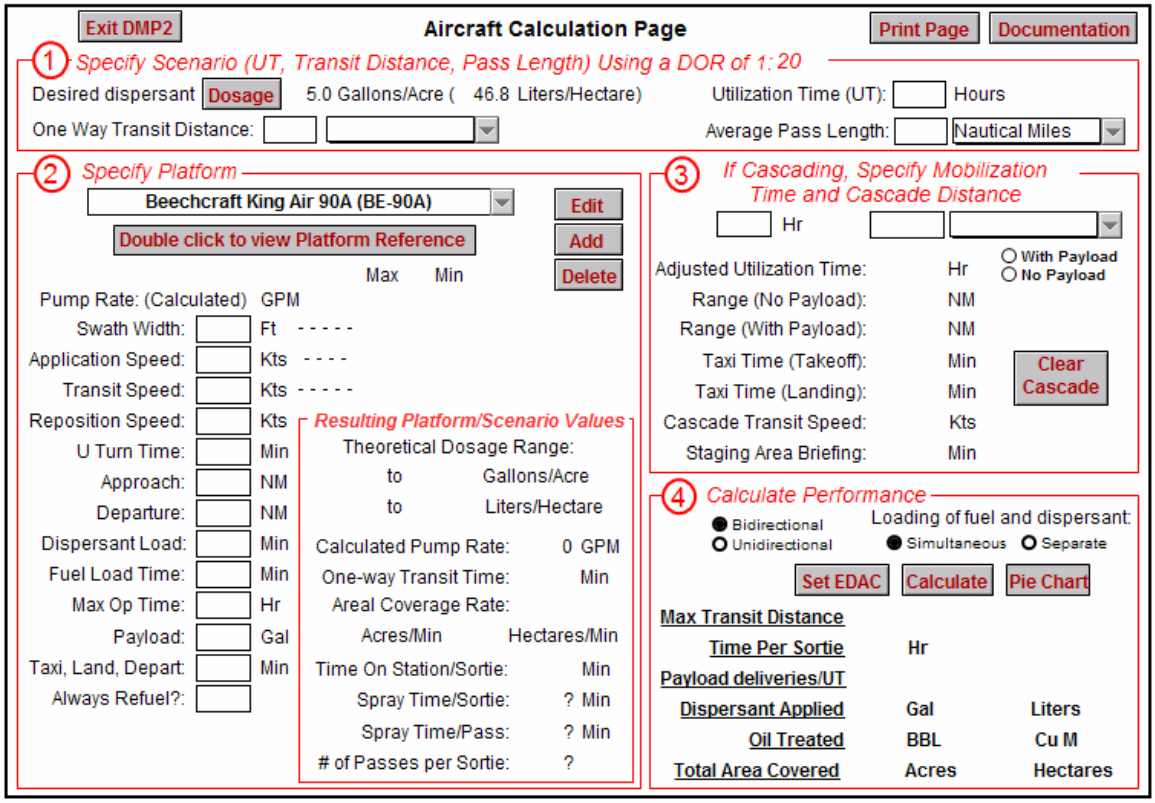
1) Accepts the default DOR (Dispersant to Oil Ratio) of 1:20 indicating 1 volume of dispersant is to be applied to 20 volumes of oil, or selects/specifies a different DOR.
2) Specifies a desired dosage (volume of dispersant to be applied to each unit of area, i.e., gallons per acre) directly (Option 1) or estimates the volume of oil spilled, the area of the oil slick, and the percent coverage of the oil slick. The resultant "average" or "nominal" slick thickness is then used with the DOR to compute a desired dosage (Option 2).
3) Selects Option 1 or Option 2.
4) Selects the Platform Type - Aircraft or Vessel.
5) Clicks on the Go To Calculation button to navigate to the Aircraft or Vessel Calculation Page.



Aircraft Calculation Page

The DOR and the desired dosage from the Dosage Page is carried into the Aircraft Calculation Page. The user:

1) Specifies the Utilization Time, the One-Way Transit Distance, and the Average Pass Length. To change the desired dosage, click on the Dosage button in this section to navigate back to the Dosage Page.
2) Specifies the platform. Note that the platform data fields need to be populated each time this page is opened from the Dosage Page. This is done by reselecting the platform name displayed or by selecting a new platform. The application speed and the swath width of the selected platform are used to calculate the necessary pump rate to achieve the desired dosage. At this point the DMP2 also calculates the theoretical dosage range of the selected platform, the one-way transit time from the staging site to the spill area, the areal coverage rate, the spray time/sortie, the spray time/pass, and the number of passes per sortie.
3) If cascading from out of area or from a home base to a staging site, the user enters the cascade distance, specifies the distance units, and specifies if cascading occurs with payload or with no payload. This results in an adjusted utilization time that is used to calculate performance instead of the UT. The cascading calculation for the supplied database of platforms includes a 45 minute briefing period prior to any dispersant spraying sorties. Platforms are fully loaded with fuel and dispersants at the beginning of Utilization Time.
4) The user specifies if dispersant application is Unidirectional (Race Track) or Bidirectional, and if loading of fuel and dispersant are simultaneous or separate operations. Click on the Calculate button to estimate the selected platform performance using its parameters, DOR, desired dosage, and the other specified spill parameters. The Set EDAC button reverts all platform parameters to their US Regulatory Calculation Values, sets DOR to 1:20, sets dosage to 5 gallons/acre, sets UT to 12 hours (for Tier 2 and Tier 3), sets the average pass length to 4 NM, sets loading of dispersants and fuel to Simultaneous, and sets spraying to Bidirectional. For Tier 1, use the Cascade section to specify the platform or dispersant (use the larger of the two) mobilization time and the cascade distance. In the EDAC mode, the one way transit distance for vessel plans is the distance from the primary dispersant staging site to the furthest extent of the 50 NM offshore contour within the COTP zone. For facility plans, the one way transit distance is the distance from the primary dispersant staging site to the facility. Click on the Pie Chart button to display a pie chart showing the time distribution of the different components of the dispersant application process within the Utilization Time.



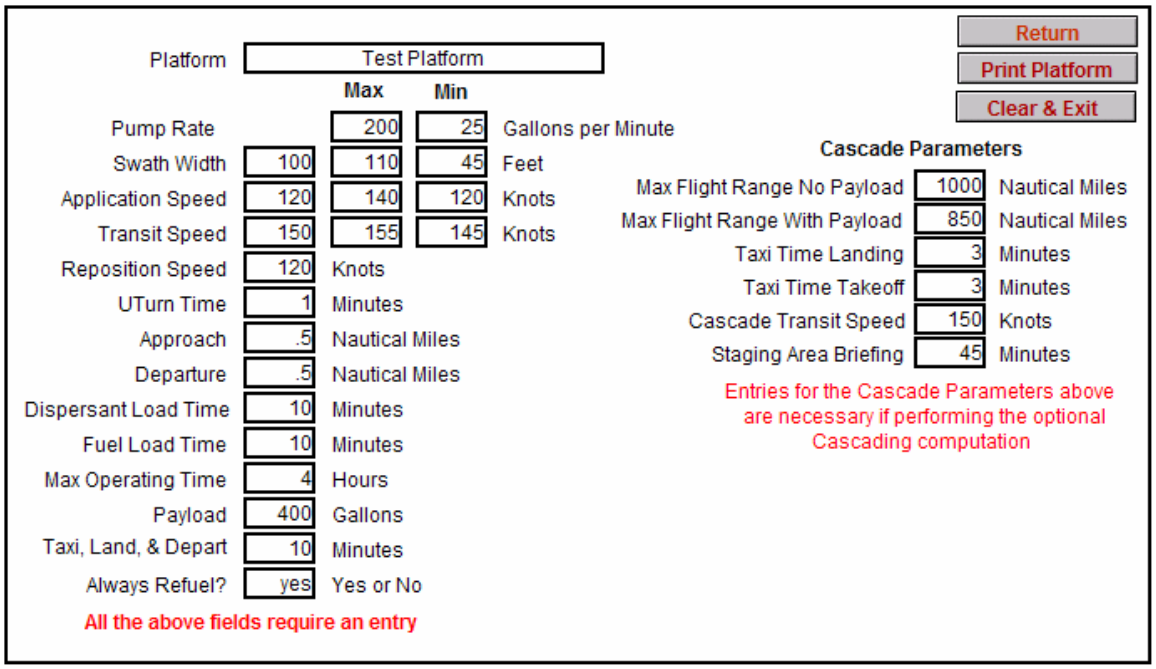
All of the aircraft platforms in the supplied database are able to deliver the EDAC Dosage of 5 gallons per acre. This is not the case with higher dosages in the variable mode. With increasing dosages, the calculated pump rate to deliver the desired dosage will exceed the maximum pump rate of the selected platform at some point. It may be possible to achieve the desired dosage by decreasing the application speed and/or decreasing the swath width of the platform. The supplied database of platforms contains maximum and minimum values for these parameters. The user of the DMP2 can attempt to achieve the desired dosage by setting minimum values for swath width and application speed, or can choose to set the pump rate to its maximum value and estimate the achieved dosage at this maximum pump rate. It may be necessary to use multiple passes over the oil slick. Users should note that the maximum theoretical dosage is calculated with the maximum pump rate, the minimum application speed, and the minimum swath width. The minimum swath width for a platform doesn't necessarily occur at the minimum application speed.

In the same manner, the user of the DMP2 may attempt to achieve low dosages in the variable mode by setting maximum values for swath width and application speed, or by setting the pump rate to the minimum value thereby determining the achieved dosage at that minimum pump rate. The theoretical range of dosages that a given platform can deliver is estimated from the ranges of pump rate, application speed, and swath width. Knowing the platform's maximum operating time and the time per sortie, an estimate of the maximum one-way transit distance for delivery of a payload is calculated and displayed (note that this calculation is made without regard to the Utilization Time).

Aircraft Platform Database

The DMP2 is supplied with a database of aircraft dispersant application systems. The data for these systems have been compiled from three general categories of sources and are available as Dispersant Aircraft Capability Forms. Category 1 indicates the data are based on documented field trials or is a fixed design value. Category 2 indicates the data are based on limited field observations or operator's stated practice or stated value (little or no documentation). Category 3 indicates the data are based on reasonable calculations or performance of comparable systems. Use the button "Double click to view Platform Reference" to access the Dispersant Aircraft Capability Forms for EDAC Platforms.

Upon entry to the Aircraft Calculation Page, the DMP2 will display the name of the last Platform used. Platform data will need to be loaded each time the Calculation Page is opened. To view the available platforms (and load the data for that platform), click and hold on the Platform Name field and select from the drop-down list. The DMP2 is supplied with 21 Platforms, 20 EDAC Platforms (18 fixed-wing and 2 helicopters) and a "Test Platform", which is a hypothetical aircraft that can be deleted and/or whose parameters can be edited by users. The EDAC platforms cannot be permanently edited nor deleted. When a platform is selected, the fields below the platform name are populated with the default values of the parameters for that aircraft. For EDAC Platforms, the default values are the EDAC values.



Adding and Editing Aircraft Platforms

Clicking on the Add button will navigate to a blank aircraft platform template. Platform names must be unique. An entry is required for all platform parameters. If the optional cascading computation of the adjusted utilization time is to be made, all cascade parameters must be entered. Valid, realistic parameters for user-defined platforms are the responsibility of the user. To exit platform data entry without saving, for example to verify data, click on the Clear & Exit button. When data entry is complete, click on the

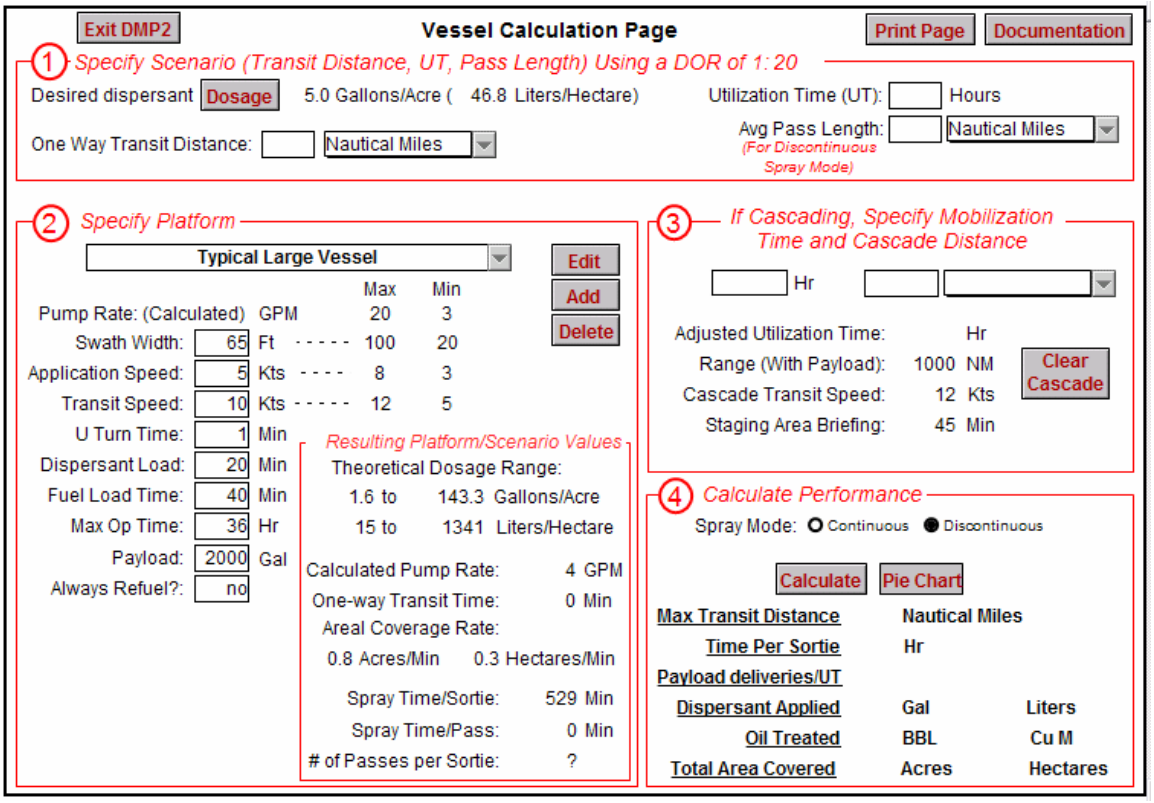
Return button to navigate back to the Aircraft Calculation Page. The platform data just entered will not display until the new platform name is selected from the platform drop-down list.

The Edit button is used to change default platform parameters for user-defined platforms only. Upon completion of edits, tap on the Return button to return to the Aircraft Calculation Page. The Print Page button prints the current platform page.

Temporary changes to platform parameters can be made on the Aircraft Calculation Page. Changes to the swath width, application speed, and transit speed will be checked against their maximum and minimum values when the Calculate button is tapped. Values outside of acceptable ranges will be restored to default values. While these checks will prevent calculations to be made for out-of-range values for key parameters, most platform parameter entries are not checked for accuracy or a range of acceptable values. The user is responsible for entering reasonable and valid data.

Vessel Calculation Page

The Vessel Calculation Page is a subset of the Aircraft Calculation Page, for example, approach and departure distances are assumed to be zero and don't appear on the page. Vessel operations are considered for two modes – Continuous or Discontinuous Spraying. In the Continuous mode the vessel transits to the spill site from the staging point, checks in with on-scene control, rigs for dispersing, and sprays continuously until dispersant is depleted or utilization time has expired. Upon returning to the staging site in the case of dispersant depletion, the DMP2 calculates if enough time remains within UT for another sortie. Discontinuous Spraying mode is defined as spraying with a specified average pass length, performing a u-turn while not spraying, spraying again for another pass, etc. until dispersant is depleted or until UT has expired.

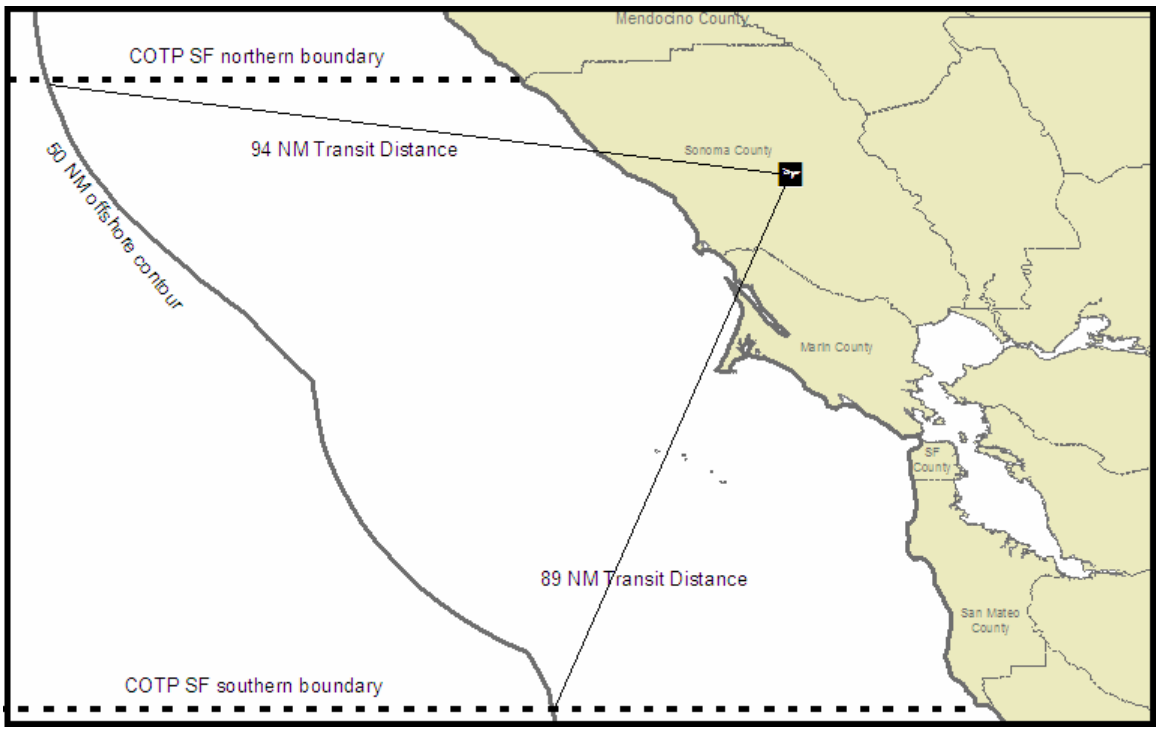


EDAC Mode

The Set EDAC Parameters button restores all aircraft platform parameters to their EDAC values when using EDAC platforms. The same button restores all user-defined platform values to their original default values. The Set EDAC button also restores the EDAC scenario:

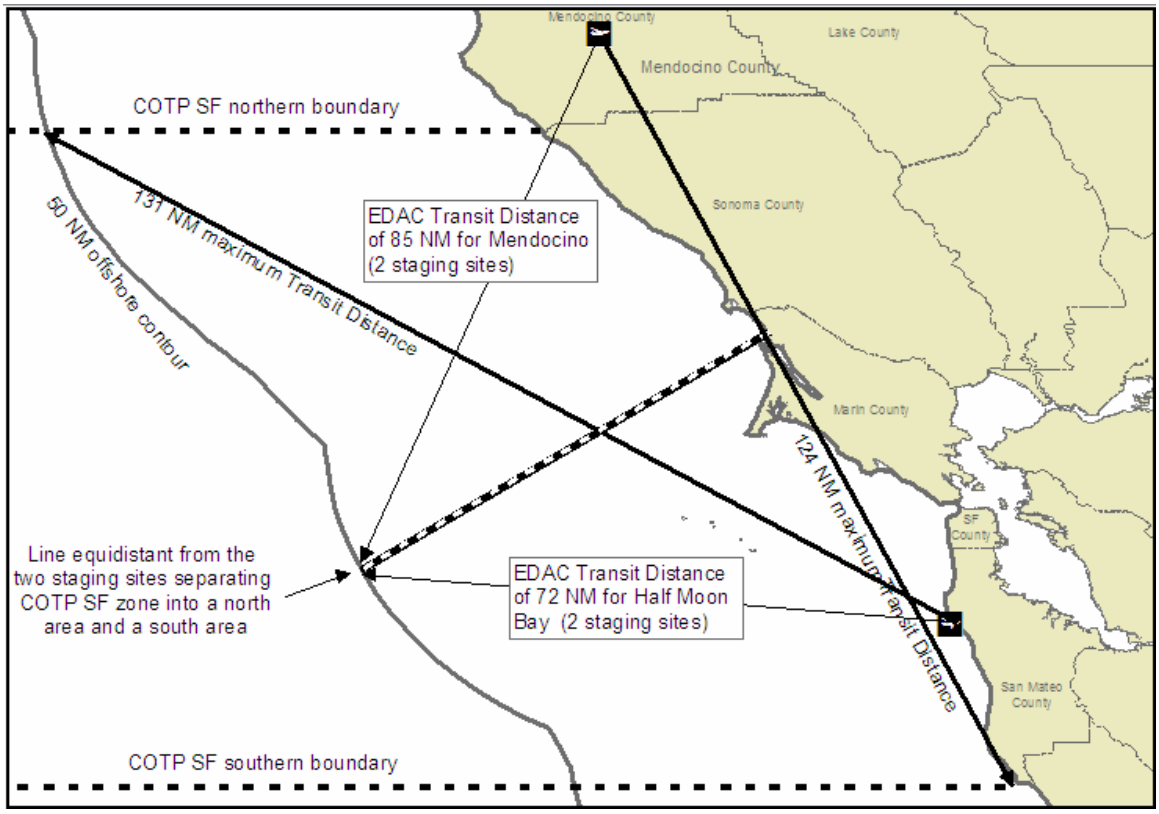
DOR – 1:20
Dosage – 5 gallons per acre
Average Pass Length – 4 nautical miles
Utilization Time – 12 hours
Simultaneous or Separate Loading of fuel and dispersant set to Simultaneous (except for C-130 H with MASS)
Bidirectional or Unidirectional set to Bidirectional

EDAC Transit Distance



This diagram illustrates the determination of the EDAC transit distance for vessel response plans for COTP San Francisco using the Sonoma County Airport as the primary dispersant staging point. Using a Geographic Information System as in this example, or manually with a nautical chart, the distance from the staging point to the furthest extent of the 50 NM off shore contour is measured as 94 nautical miles. This is entered as the One Way Transit Distance in the DMP2 to calculate the EDAC value for a specific platform within the San Francisco COTP zone using the Sonoma County Airport as the primary dispersant staging site.

Note that more than one dispersant staging site can be specified in a vessel plan. The COTP zone could be divided into areas for each staging site. See the following example for two possible staging sites, the Mendocino County Airport and the Half Moon Bay Airport. If the Mendocino County Airport was the only staging site specified in the plan, the EDAC Transit Distance would be 124 NM. The EDAC Transit Distance for Half Moon Bay would be 131 NM if it were the only staging site specified in the plan. However, if both airports were specified as staging sites in the plan, the COTP zone could be divided into two areas by a line equidistant from the two airports. The diagram shows the San Francisco COTP zone with a dispersant staging site at the Mendocino County Airport for the northern area of the COTP zone with a EDAC Transit Distance of 85 nautical miles and a dispersant staging site at the Half Moon Bay Airport for the southern area of the COTP zone with a EDAC Transit Distance of 72 nautical miles.



For facility response plans, the EDAC Transit Distance is measured from the primary dispersant staging site to the facility.

Calculate Performance

The Calculate button performs several data validation checks before estimating the performance for the selected platform. Included in the estimates are the maximum transit distance, time per sortie, the payload deliveries within UT, the volume of dispersant applied (gallons and liters), the total area covered (acres and hectares), and the volume of oil treated (barrels and cubic meters). The Print Page button prints the Calculation Page.

Assumptions

Platform performance calculations do not include the time required for the initial mission briefing, fuel, and dispersant loading operations.

A sortie is the combination of all operations for the application of one payload of dispersant on the oil slick. The Time per Sortie is the out and back time without regard to loading dispersants or refueling. Each sortie begins with the aircraft loaded with dispersant and fuel. Each dispersant application sortie is divided into component parts.

Each aircraft delivery system is described by platform parameters that specify how much time is required for each component of the sortie for that system.

Note that use of the DMP2 assumes Visual Flying Rules prevail and that weather conditions are conducive to dispersant application.

Application speeds are assumed to be over-the-ground. It is acknowledged that all aircraft have a range of acceptable air speeds for safe operations; however, when the effects of wind are considered the resulting ground speeds may vary considerably. For example, a C-130 with the ramp open and spray arms extended may have an acceptable air speed range of 145-150 knots. When flying into a 10 knot wind, the ground speed would drop to 135-140 knots, 5–10 knots below the assumed application speed of 145 knots. As the wind speed increases, this variation becomes greater. Flying with the wind results in similar, but increasing alterations of the ground speed. These variations are not included in the EDAC calculation because of the greater uncertainties associated with oil slick thickness and actual Dispersant-to-Oil Ratios (DORs).

There is no side overlap between spraying passes.

The DMP2 calculates the pump rate necessary to achieve the specified dosage. The DMP2 checks to insure that the calculated pump rate is between the maximum and minimum pump rates and assumes that the selected platform can deliver the calculated pump rate. Users should note that the maximum theoretical dosage is calculated with the maximum pump rate, the minimum application speed, and the minimum swath width. The minimum swath width for a platform doesn't necessarily occur at the minimum application speed hence the "theoretical" caveat.

The DMP2 performs some checks on user entered data, but ultimately it is the responsibility of the user to enter realistic data.

Check-in Time is the time specified at the beginning of each sortie for the aircraft to check in at the spill site with spotter aircraft, complete safety procedures, etc. The DMP2 assigns 10 minutes at the beginning of each sortie for all platforms for check-in time.

Definitions

Adjusted UT – The reduced Utilization Time available for dispersant operations due to cascading aircraft from out-of-area to the staging airfield.

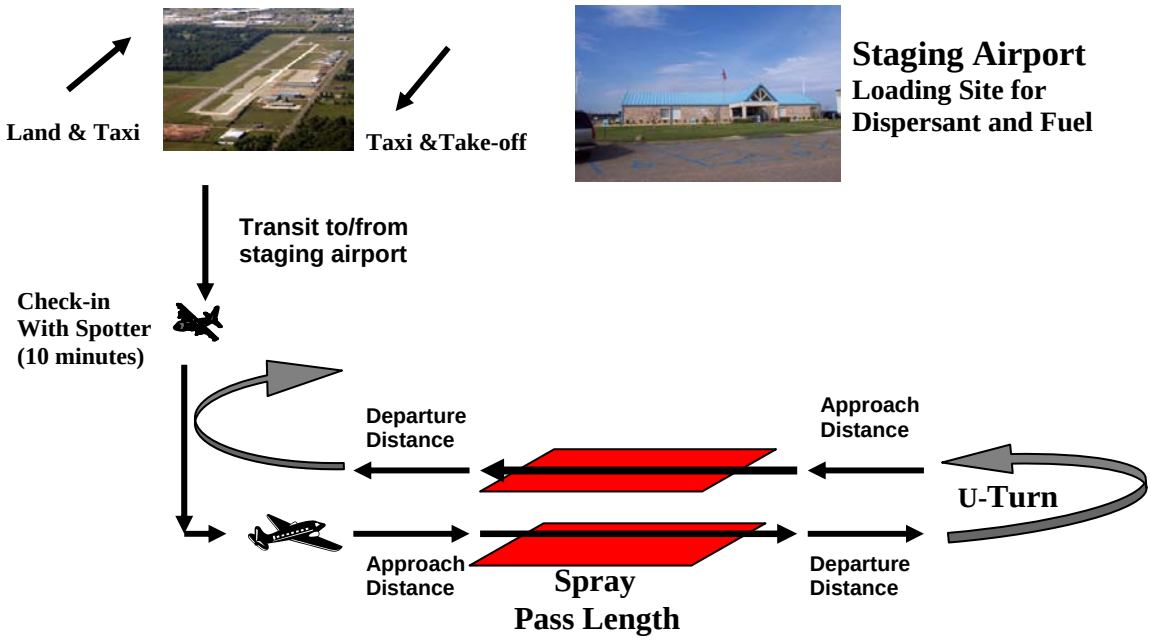
Application Speed – The ground speed at which the platform applies dispersant.

Approach Distance – The Approach is the distance the aircraft is aligned on course for the spray pass at Application Speed prior to commencing dispersant application. See Race Track and Bi-directional Application Diagrams.

Areal Coverage Rate – The sprayed area per unit time of actual spraying. The DMP2 units are acres per minute and hectares per minute.

Average Pass Length – The average length of the dimension of the oil slick that is parallel to the flight track while spraying. In EDAC mode, the Average Pass Length is set at 4 nautical miles.

Bi-directional – Mode in which the platform sprays dispersant in both directions over the oil slick.



Cascade Distance – The distance from the home base to the primary dispersant staging site.

Departure Distance – The distance the aircraft continues on course and at application speed before commencing repositioning maneuvers. Departure Distance for vessels is assumed to be zero. See Race Track and Bi-directional Application Diagrams.

Dispersant Load Time – The time necessary to load dispersant into the tank on the dispersant platform. In EDAC mode it is assumed that dispersants and fuel are loaded simultaneously except for the U.S. Air Force policy for operating the USAF C-130 H MASS platform where they are loaded separately.

DOR – The Dispersant to Oil Ratio is the ratio of the volume of dispersant to the volume of oil to be treated. In EDAC mode, the DOR is 1:20, meaning 1 volume of dispersant is applied to 20 volumes of oil.

Dosage – The volume of dispersant applied to a given area. Units can be gallons/acre, liters/ square kilometer, or liters/hectare.

Fuel Load Time – The time necessary to load fuel onto the spraying platform. In EDAC mode it is assumed that dispersants and fuel are loaded simultaneously with the exception of the C-130 H MASS.

Maximum Operating Time – The maximum time a platform can operate with a full payload while retaining a regulatory fuel reserve for aircraft platforms. In the U.S. this is a 45 minute reserve.

Maximum Transit Distance – The maximum one-way distance a platform can travel to an oil slick and deliver a payload within its maximum operating time (note that the maximum transit distance is not defined relative to the UT). It is determined by setting the time per sortie equal to the maximum operating time.

Payload – The maximum volume in gallons of dispersant a platform can carry.

Platform – The dispersant-application platform is the vessel or aircraft outfitted with the dispersant-application equipment acting as the delivery system for the dispersant onto the oil spill.

Pump Rate – The rate in gallon per minute at which dispersant is pumped through the dispersant spraying system. The DMP2 computes the pump rate necessary to achieve the desired dosage, based on the application speed and the swath width.

Return Leg – Distance in "Race Track" or Uni-directional mode during which an aircraft platform transits to the opposite end slick area at reposition speed without spraying. Return Leg Distance = Approach Distance + Average Pass Length + Departure Distance.

Sortie – One operational flight of a dispersing aircraft from taxi and takeoff at the staging airport, transit to the oil slick location, check in with the spotting aircraft, spraying a payload of dispersant, transit back to the staging airport, and landing and taxi. A sortie does not include refueling of the aircraft or loading of dispersant. For vessels, a sortie encompasses all activities and operations from the time the vessel departs the primary dispersant staging site to the spill area, sprays dispersant, and returns to the primary dispersant staging site.

Swath Width – The length measured perpendicular to the dispersant application track between the points at which delivery on the oil slick drops below 90% of the designed dosage (ASTM Standard F 1413-92).

Taxi, Land, Depart – The elapsed time for aircraft platforms from initial movement on the ground to wheels-up at the beginning of a sortie plus the time from touch- down to when the aircraft comes to a complete stop at the staging airfield at the end of a sortie.

Time On Station/Sortie – For aircraft, this is an estimate of the time at the spill site for each sortie including the 10 minute check-in time.

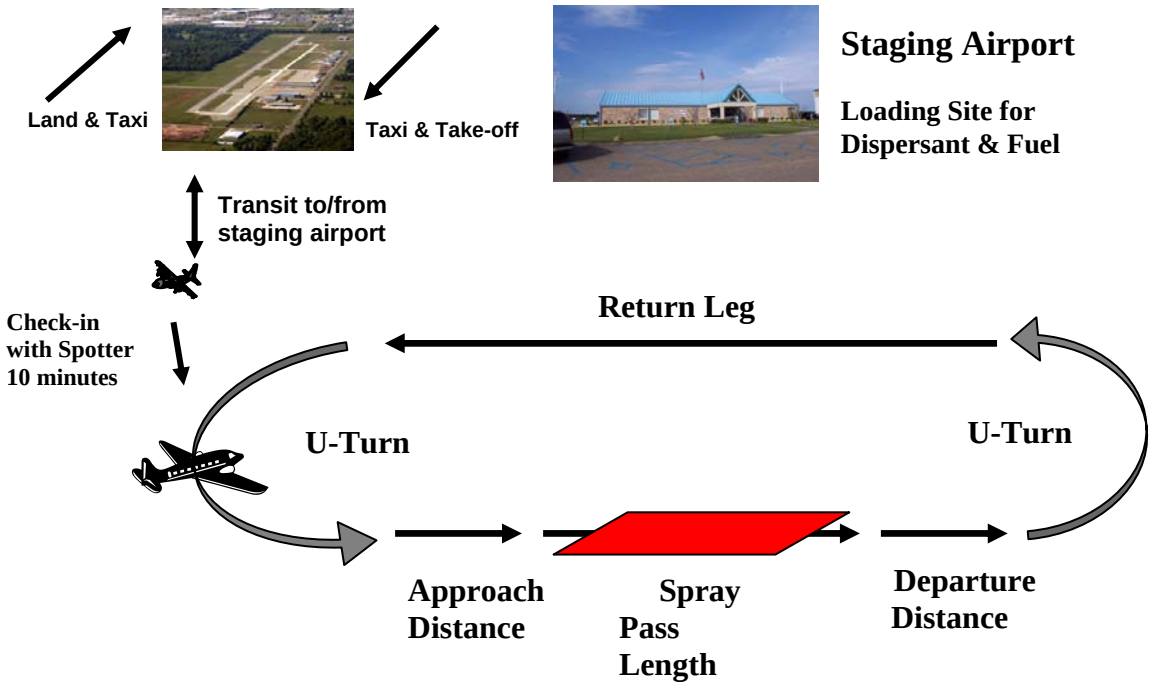
Time per Sortie – The time necessary to complete a sortie including platform startup, departure from the staging area, transit to the spill site, spraying of one payload, transit back to staging area, and platform shutdown. Time per sortie does not include loading of fuel or dispersant.

Transit Distance – The one-way distance from the staging site to the location of the oil slick. The transit distance for vessel response plan EDAC calculations is measured from spill sites 50 nautical miles off shore furthest from the primary dispersant staging site within the COTP zone.

Transit Speed – The ground speed of the dispersant platform between the staging site and the area of the oil slick.

U Turn Time – The time necessary for the dispersant platform to make a 180 degree turn between spraying passes.

Uni-directional – Sometimes called "Race Track" mode in which an aircraft platform sprays in one direction only (usually upwind) over the oil slick. On the return leg, the aircraft transits over the oil slick without spraying.



Utilization Time – The time available for dispersant operations during daylight hours. For EDAC, the Utilization Time (UT) is set at 12 hours. UT does not include the final transit time back to the primary dispersant staging site at the end of the last sortie.

DMP2 Logic

The EDAC for a specific application system is determined by the number of complete sorties plus a final partial sortie, if possible, that can be accomplished within an Utilization Time of 12 hours.

There are two primary calculation modes for dispersant aircraft, Bidirectional and Unidirectional. In the Unidirectional mode, spraying of dispersants is in one direction only, usually upwind. At the end of each spray pass, the platform makes a departure followed by a u-turn, and then proceeds back over the slick (return leg) without spraying. After another u-turn and an approach, the platform makes another spray pass across the oil slick. This Unidirectional mode is also referred to as a "Race Track" pattern.

The Time per Sortie for Unidirectional spraying is the summation of the following list of elements:

Taxi, Land, Depart +
Transit Time out to spill site +
Check-in Time upon arrival at spill site (set at 10 minutes)
+
Approach Time+
Spray Time for One Pass+
Departure Time+
U-Turn Time+
Return Leg Time+
U-Turn Time
} repeat and sum for each complete pass
+
Approach Time +
Spray Time for Last Pass +
Transit Time back to staging area

Spraying in the Bidirectional mode is both in the upwind and downwind directions. After a spray pass upwind across the slick, the aircraft makes a departure and a u-turn and immediately sets up for an approach for the next pass in the downwind direction. Note that for Bidirectional spraying that the departure for one pass is the approach for the next pass so they are necessarily equal distances.

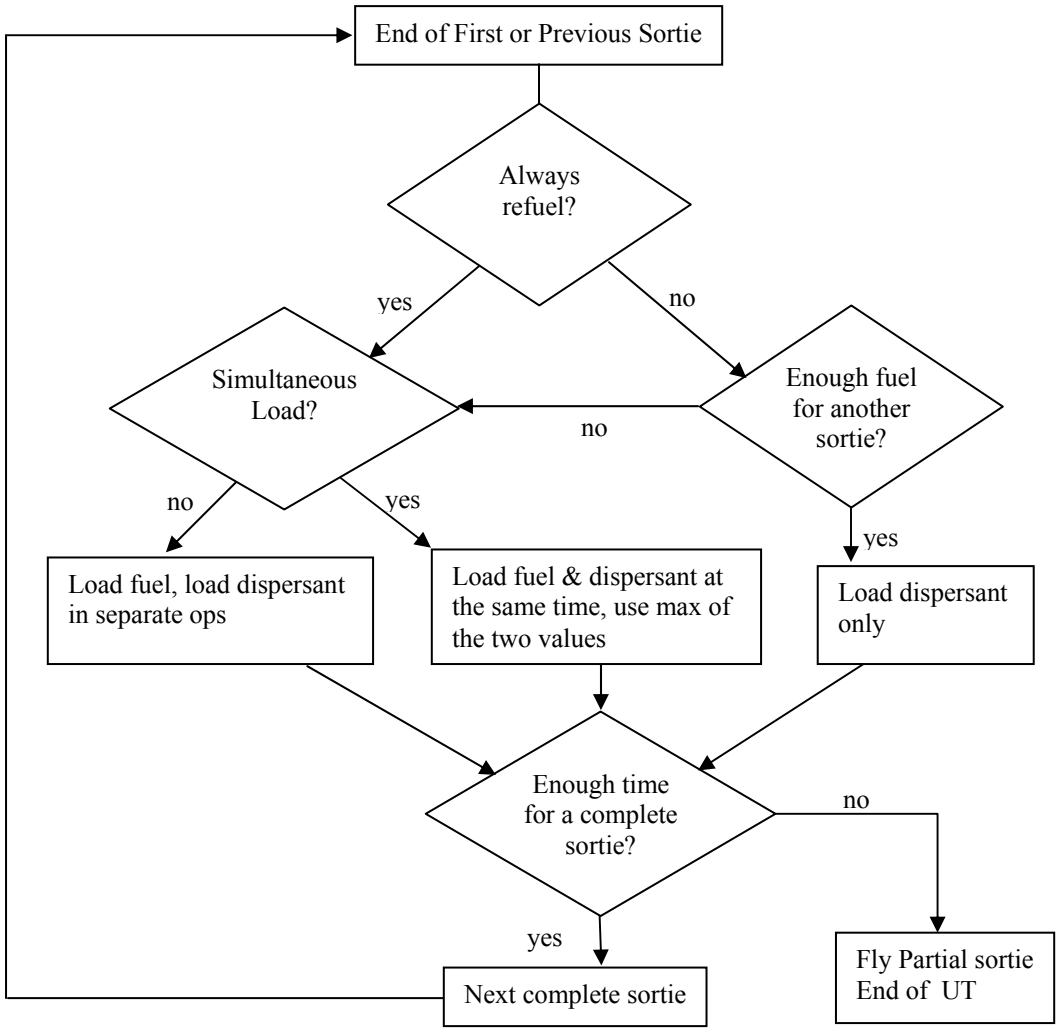
The time per sortie for Bidirectional spraying is the summation of the following list of elements:

Taxi, Land, Depart +
Transit Time out to spill site +

Check-in Time upon arrival at spill site (set at 10 minutes)
+

Approach Time +
Spray Time for One Pass+ } repeat and sum for each complete pass
Departure Time +
U-Turn Time
+
Approach Time +
Spray time for Last Pass +
Transit Time back to staging area

At the end of each sortie for both Bidirectional and Unidirectional modes the following logic is applied to determine if there is sufficient time within the remaining utilization time for another complete or partial sortie.



There will always be a dispersant load at the end of each sortie but not necessarily a fuel load. There is also the consideration of a simultaneous fuel/dispersant load which may be plan dependant. For these reasons the time per sortie calculation does not include loading of fuel or dispersants. It is the summation of only those time elements necessary to go "out and back."

As the previous diagram illustrates, the number of sorties per UT is a function of the number of complete sorties possible, plus any spraying that can be accomplished within the UT in a final partial sortie. To allow for maximum performance for a specific platform within the UT, the final transit from the spill area back to the staging area can occur after the UT has ended.

Equations

The optional cascade calculation provides for simulation of cascading platforms from an out-of-area location to the staging airfield. This is done with the entry of a cascade distance and specifying if the platform is flying with an empty payload or with a full load of dispersant. To perform this calculation, the following fields in the current platform record must have entries:
Max Flight Range No Payload
Max Flight Range With Payload
Taxi Time Landing – TTLand
Taxi Time Takeoff – TTTO
Cascade Transit Speed – Cas Tran Spd
Staging Area Briefing – Brief (set at 45 minutes for platforms in the database)

The Adjusted UT is computed by subtracting the mobilization time plus the necessary cascading time (including landing, taxi, and refueling times if needed) from the UT. The Adjusted UT is then used instead of the UT for the performance calculation when cascading.
For Cascade Distance ≤ Max Flight Range:

$$\text{Adjusted UT[Hr]} = \text{UT[Hr]} - \frac{\text{TTTO[Min]}}{60} - \frac{\text{Cascade Distance[NM]}}{\text{Cas Tran Spd[kts]}} - \frac{\text{TTLand[Min]}}{60} - \frac{\text{Brief[Min]}}{60}$$

For Cascade Distance > Max Flight Range:
Number of Segments in the Cascade = NOS

$$\text{NOS} = \frac{\text{Cascade Distance[NM]}}{\text{Range[NM]}}$$

NOS has an integer part, NOSInt and a fractional part, NOSFrac

$$\text{Adjusted UT[Hr]} = \text{UT[Hr]} - \frac{\text{TTTO[Min]}}{60} - \frac{\text{NOSInt} * \text{Range[NM]}}{\text{Cas Trans Spd[kts]}} -$$

$$\text{NOSInt} * \left(\frac{\text{TTLand[Min]}}{60} + \frac{\text{TTTO[Min]}}{60} + \frac{\text{Fuel Load Time[Min]}}{60}\right) -$$

$$\text{NOSFrac} * \frac{\text{Range[NM]}}{\text{Cas Tran Spd[kts]}} - \frac{\text{TTLand[Min]}}{60} - \frac{\text{Brief[Min]}}{60}$$

$$\text{Transit Time[Min]} = \frac{\text{One Way Transit Distance [variable units]}}{\text{Transit Speed[kts]}}$$

(note that Transit Speed is not Cascade Transit Speed)

$$\text{Areal Coverage Rate[Acres per Min]} = \frac{\text{Application Speed[kts]} * \text{Swath Width[ft]}}{430}$$

$$\text{Pump Rate[gpm]} = \frac{\text{Dosage}[\frac{\text{gal}}{\text{acre}}] * \text{Application Speed [kts]} * \text{Swath Width [ft]}}{430}$$

$$\text{Spray Time per Sortie[Min]} = \frac{\text{Payload}[\text{gal}]}{\text{Pump Rate}[\text{gpm}]}$$

$$\text{Spray Time for One Pass} = \frac{\text{Average Pass Length}[\text{NM}]}{\text{App Speed}[\text{kts}]}$$

$$\text{Number of Passes per Sortie} = \frac{\text{Spray Time per Sortie[Min]}}{\text{Spray Time for One Pass[Min]}}$$

> The integer part of this computation is used to determine the number of complete passes of a sortie. The decimal part determines the extent of the last partial pass before the end of the sortie.

In the Unidirectional mode, Return Leg Time is the summation of the Departure Time, time to transit the Average Pass Length at Reposition Speed, and the Approach Time (U-Turn Time is a separate variable).

The Maximum Transit Distance is useful to estimate how far from the staging airport an aircraft platform can travel to a spill site, deliver a payload of dispersant, and return to the staging airport within its maximum operating time. It is derived by setting the Time Per

Sortie result equal to the Maximum Operating Time for the Platform and then solving the equation for the Transit Distance.

The maximum theoretical dosage a platform can deliver can be estimated by solving the pump rate equation above for dosage and use the platform maximum value for pump rate and platform minimum values for application speed and swath width

$$\text{Max Dosage[gal/acre]} = \frac{\text{Max Pump Rate[gpm]} * 430}{\text{Min App Speed[kts]} * \text{Min Swath Width[ft]}}$$

In the same way the minimum theoretical dosage is:

$$\text{Min Dosage[gal/acre]} = \frac{\text{Min Pump Rate[gpm]} * 430}{\text{Max App Speed[kts]} * \text{Max Swath Width[ft]}}$$

The number of payload deliveries within the UT is incremented for each sortie completed with a possible partial payload delivery at the end of the UT.

$$\text{Dispersant Applied[gal]} = \text{Payload Deliveries within UT} * \text{Payload[gal]}$$

$$\text{Oil Treated[bbl]} = \frac{\text{Dispersant Applied[gal]}}{42}$$

$$\text{Acres Covered[acres]} = \text{Payload Deliveries within UT} * \text{Spray Time per Sortie[Min]} *$$

$$\text{Areal Coverage Rate}[\frac{\text{Acres}}{\text{Min}}]$$