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OPERATORS GUIDE:
ATMOSPHERIC RELEASE ADVISORY CAPABILITY (ARAC)
SITE FACILITY

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ABSTRACT

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In this report we describe capabilities and services of the Atmospheric Release Advisory Capability (ARAC). We outline the ARAC site system and describe its operating procedures and interactions with the ARAC central facility located at LLL. ARAC is designed to help officials at designated ERDA sites and other locations in estimating the effects of atmospheric releases of radionuclides or other hazardous materials by issuing real-time advisories to guide them in their planning.

INTRODUCTION

ARAC is a service to assist designated ERDA sites and other locations in estimating the effects of the releases of radionuclides or other toxic materials to the atmosphere.¹ ARAC provides, in real-time, a series of advisories from which responsible officials can act in the event of sudden emergency or routine atmospheric release. These advisories are based on calculations from numerical models with input data from the site of release, as well as on meteorological data from national weather agencies. State-of-the-art technology for communications, data handling, and dose conversion are used in the ARAC system.

ARAC responds to releases from those designated ERDA sites that have been properly equipped for the purpose, and can respond also to releases or threats at other locations around the world, provided information about the source of release can be obtained. The ARAC central facility (ACF), located at Lawrence Livermore Laboratory, serves as the center for data acquisition, assessments, and communications for ARAC. During normal operating conditions, environmental data together with any messages from ARAC-serviced sites (site facilities) would be transmitted at 4-h intervals to the central facility for processing and storage. In event of an emergency, a data and voice communication would be immediately established between the site and the central facility.

Each ARAC-serviced site has a minicomputer that can acquire, assess, and communicate local data. On demand, the site facility continuously calculates and displays Gaussian diffusion estimates for close (<5 km) downwind locations using current local meteorological data. The site facility also transmits such local meteorological measurements to the ACF, and from the ACF it receives for graphic display estimates of regional (<100 km) effects.

Site Facility Hardware

The site facility hardware is illustrated in Fig. 1. The central processor is a DEC PDP-11 with a maximum memory of 28K words. The system uses a Dectape system and data storage medium. There are two graphical output devices for displaying maps, overlays, and similar information. The first graphical output device is the 17-in. CRT monitor that uses a 28K memory to refresh the graphic display. The second graphical output device is the 11-in. printer/plotter that is referred to as the hard-copy device because the display is documented on paper. The keyboard and the light pen are two devices the operator uses for communicating with the computer. The operator can type appropriate responses on the keyboard to provide input data and to communicate with the site facility. Using the light pen, the operator can point to a command for an appropriate system response. There is a watch-dog timer and bootstrap function for starting the site system and restarting when the system is stopped by unexplained or undetected errors. There are also data lines used to collect data from meteorological towers and to communicate them to the ACF.

Site Facility Controls

Two functions of the site facility minicomputer are: calculation of a Gaussian diffusion estimate every 15 min based upon average data collected from the meteorological towers, and interactive responses to the operator's data input.

The user can display all of the computation products in the form of a forecast advisory. Some of these computations are described below.

Gaussian Diffusion Calculation

The Site System Gaussian diffusion calculation is adapted from a Continuous Point Source (CPS) code² and is easy to use. The CPS code is used to plot concentration estimates based on the spread of released pollutants in the

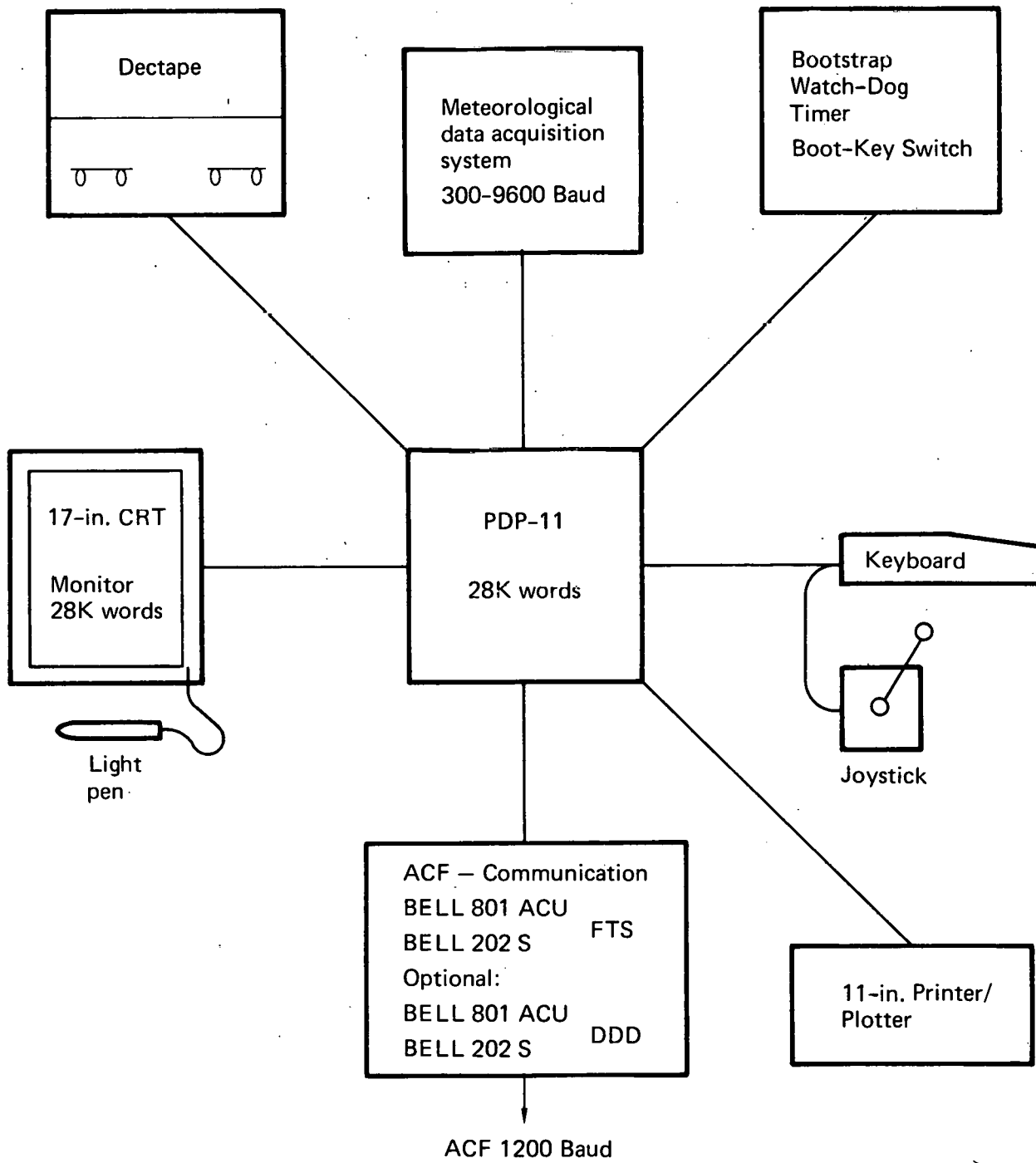


Fig. 1. ARAC site facility hardware.

direction of the wind. For each calculation, the release is assumed to be infinite and the wind constant in direction and speed. For a quick first estimate, these assumptions are valid; however, we suggest that the limits of the Gaussian diffusion estimate be restricted to approximately 5 km downwind from the source. Most of the measures affecting the Gaussian estimate may be set up as an assumption by the operator (see GAUSSIAN DIFFUSION).

Because the term and rate of release from the source may vary, no reasonable response from the ACF may be expected within the time the Gaussian calculation is useful. ARAC has therefore assumed the release rate to be unity. When a release rate (in units/sec) is known, then the user can label his printed output with absolute values.

Both the release height and the sample height control the rate of vertical diffusion of released material. The release height is the distance above ground at which the column of material (puff or plume) stabilizes; the sample height is the distance above the ground for which the concentrations of hazardous materials are to be estimated. The sample height of most interest is normally 2 m, which is the breathing level for most persons. The difference in these heights affects how far downwind the estimated concentration contours appear. There is no compensation for variations in topography in the Gaussian diffusion calculation. Although no term for material deposition is yet included in the Gaussian calculation, we plan to add this feature in the future.

Radioactive decay within the release will gradually decrease the concentration downwind from the source. Released materials with short half-lives also shorten and compress the concentration contours, since rapid decay tends to decrease the concentration as a function of distance over time. Half-life, when set to 10 billion seconds, will have no effect on the Gaussian estimate.

The Pascal-Gifford stability classification is used to determine σ 's for the downwind and crosswind direction. The stability classes are related to how much the plume is spread out, or diluted, by wind. In a low-numbered stability class (1, or category A), the plume is very unstable and therefore its contours will be wide; in a high-numbered stability class (6, or category F), the plume is very stable and therefore its contours will be narrow. The σ 's associated with each class are a function of the distance from the release point. With these σ 's, the Gaussian diffusion estimate is easily calculated. In the future, we plan to obtain the horizontal diffusion parameters directly from the horizontal wind angle σ 's.

The release point is prescribed for the calculation by coordinates that the operator sets using the site maps. The coordinates remain the same until changed by the operator.

The above factors influencing the Gaussian diffusion estimate can be used as defaults after the operator has selected those of interest. These factors are specified by typing SET PARAMETER. If set up as defaults when the operator selects the Gaussian diffusion calculation, time and tower height wind data are the only additional measurements that are required when the system is queried. In the future, we plan to add the Gaussian calculation for an instantaneous point source (IPS) in addition to allowing for CPS and IPS calculations involving particulate releases.

Trajectory Calculations

The ACF can estimate the path a particle would take in the center of the plume or puff, using meteorological data from the site and other sources. The site facility cannot calculate a trajectory but can display the results of the calculation performed at the central facility.

Regional Model Calculations

The regional model calculations are more complex than those for the trajectory. The regional models account for variations in topography, wind shear and the duration of the release. With these data, we can accurately predict at a specific point the shape and size of the plume in terms of its concentration.

Under present operating conditions, the ARAC emergency team must be assembled, and the regional codes (MATHEW³/ADPIC⁴) run on the CDC 7600 computers at LLL. In the future, when the ACF is staffed 24 h a day, a team will be available to initiate these calculations within minutes. After ARAC is notified of a release, the site operator may expect the ACF to send results to the site within approximately 40 min assuming that a 24-h operating staff is available. The site operator can then display the contours of concentration and dose.

Additional Site System Features

The site facility can also be used by the operator to format and display the data available to it, and to communicate with the ACF. The scale and

location of plots and displays can be chosen by the operator. Communication is initiated automatically with the ACF in most cases; but when the operator needs to notify ACF of an emergency or other condition, then he can initiate and control communications to the center.

Site System Priorities

There are limited computing resources available within the site system; the resources must be shared with all of the functions. Because of this, there are priorities of the site system's functions. The operator has the lowest priority and therefore may be interrupted at any time to wait for another calculation to be completed. The operator will have to restart his calculation once interrupted. Sometimes he will lose no information, while at other times the entire process must be restarted. ACF communications has the next highest priority. Communications will be infrequent and often at the operator's request, so they should not conflict with functions of lower priority.

Updated data from meteorological towers will arrive to the system every 15 min and this function will override the operator from 20 sec to several minutes.

KEYBOARD OPERATION OF SITE SYSTEM

As soon as possible, the operator should become familiar with the keys on the console. In addition to the numerical and alphabetical keys, the keyboard has special keys with specific functions described below.

ESCAPE/ALTERNATE MODE. This key, located in the upper left corner of the keyboard, gains the attention of the site system. Some keyboards have keys with <ESC>, while some have keys with engraved <ALT> on them, but their meaning is identical. Some programs may require more than one <ESC> function while others may delay a number of seconds before responding. If the operator strikes this key several times, the MENU (see below) will appear.

CARRIAGE RETURN. This key, located on the console's far right edge, has <CR> engraved on it. Any numerical input by the operator must be followed by a <CR> input. This allows any other non-numeric key to be used sequentially, if desired. Striking <CR> will enter \emptyset if no numeric key is struck first.

LINE FEED. This key (<LF>) is adjacent to the <CR> key. Striking <LF> allows the operator to ignore, skip or reject the current input.

RUBOUT/DELETE. This key, engraved with either $\begin{matrix} \text{RUB} \\ \text{OUT} \end{matrix}$ or , has no function at this time, but may be put to use later.

NUMERIC KEYS. These keys are located at the top of the keyboard or on the optional keypad to the right. Both sets are active if present. As noted above, a <CR> command must always follow any entry with these keys.

ALPHABETIC KEYS. At present, only the <P> key is used to make a hard copy of almost all of the displays. A <CR> command is not required to follow the alphabetic keys.

OPERATOR-MENU INTERACTION

Two hits to the <ESC> key brings up the MENU. The MENU is the starting place for selecting the display options (see list below). To select an option from the MENU, the proper numeric key is hit followed by a <CR> command. Before selecting MENU options, it is necessary to set pertinent information into the computer in advance. For example, if the <1>, <CR> keys are hit, the alternative for parameters are displayed, with the next option to be selected set blinking. Blinking zeros indicate the maximum number of integers called for in that entry. If the entry is to be skipped, striking <LF> will retain its current value, and the next entry will begin blinking. A command of <^> permits the operator to back up the parameter list to change a previously selected value.

The following are the *display options* that may currently be selected on the MENU:

SET PARAMETERS. For the Gaussian calculation, the following parameters are required by entry or default: release height, sample height, radioactive half-life, stability, and wind speed and direction, if different from the tower values. The current time and date are also displayed here.

WIND ROSE. Typing a <P> or touching the word PLOT with the light pen will produce a copy of the WIND ROSE on the plotter. The WIND ROSE function has the temperature range and current temperature for the last four hours displayed in graphical format the lower left corner. The last

two hours of wind data are displayed as vectors on a compass rose. The vectors are automatically scaled to a reasonable length. The vectors are located so that the wind direction is along them towards the center. The data are displayed for one tower level at a time. To select the desired tower, either point to the meteorological tower name with the light pen then to the word TOWER, or type the line number on which the tower name appears and follow with a <CR> command.

METEOROLOGICAL DATA. This function displays in tabular form all of the meteorological data available at the site. These data can be presented in two forms. The operator can select the data at all times for one tower level or the data for all towers at one time.

To select the data for one tower level, the operator should point to the name of the tower and then the word TOWER with the light pen, or type the line number on which the tower name appears and follow with a <CR> command.

To select all of the towers for a given time, the operator must type <LF> or select with the light pen the message which describes the line feed option. Then the input will be for TIME rather than TOWER, which the operator selects the same way as for TOWER.

To obtain a printed copy of these data, the operator should select PLOT on the MENU and then select this function on the PLOT MENU.

SITE MAP/SITE MAP (DETAILED). The coordinates of the release center are set with these functions. The two maps displayed are independent of each other so that the release center must be specified on both functions. This gives the flexibility to look at different release centers at different scales. The tracking cross, which marks the current release center can be moved to a new position by the light pen or the joy stick. The Universal Transverse Mercator (UTM) coordinates of the tracking cross are constantly updated and displayed in the upper left corner. When the release center is set, the operator may finish by touching EXIT or typing ESCAPE. To obtain a copy of this map, hit the <P> key or touch PLOT with the light pen.

REGIONAL MAP/TRAJECTORY MAP. These two functions are used to establish two different maps for displaying overlays and to control their size and centering. A map can be displayed with different options as defined.

The operator can change the size or centering of the map by selecting a new scale, or by moving the tracking cross. To make these changes permanent, the operator must select NEXT MAP with the light pen or type <CR>. If the operator wishes to again work with his previous map, he can type OLD MAP or hit the <O> key. If the operator wishes a copy of this map, he types PLOT or <P>. To move the center of the map, the operator uses the tracking cross and the light pen, or the joy stick. To scale the map, the operator selects one of the seven scales listed, or types to reduce the scale or <S> to increase the scale. The size and UTM coordinates are displayed and updated on this function. When the operator has displayed the map he wishes to use, he types EXIT or <ESC> to return to the MENU.

GAUSSIAN DIFFUSION. Using this function, one can calculate a continuous-point Gaussian diffusion contour. Since this function is independent of time, the program has assumed a constant wind speed and direction. The operator must define the parameters of the release by first using the SET PARAMETER function. The operator's first choice in using GAUSSIAN DIFFUSION is whether to use the wind speed/direction in SET PARAMETER, or to use one of the tower levels. A <Y> instruction indicates that the trial wind speed/direction will be used, whereas typing a <N> will skip this instruction. This selection can also be made by pointing the light pen to TRIAL DATA, or it can be skipped by pointing to INPUT SKIP. If TRIAL DATA is not selected, the operator types the line number of the tower he wishes to use, followed by the line number of the time interval. The light pen can also be used to select either the TIME and TOWER, by selecting the appropriate line which will begin flashing. When the correct line is flashing, the operator selects TOWER, the line will stop flashing, and TOWER will indicate the line that was selected. The same procedure is repeated for TIME.

After wind speed and direction data have been selected, the choice of site maps will be presented. The choices are DETAILED or REGULAR. The option is selected with the light pen or by typing a <D> or <R>, respectively. The calculation is now begun and requires 5 to 10 s to complete. During this time the screen is blank.

TRAJECTORY MODEL. This function can be calculated at the ACF by using the meteorological data received from the site and surrounding airports.

Data from the airport come via a data link between the ACF and the Air Force Global Weather Central (AFGWC). The trajectory calculation will depict the path that the center of a puff or a plume follows as it leaves the source. This function has not yet been implemented but it should be available to the user soon.

LOCAL WEATHER. This function allows the user to obtain reports of local upper-air weather data that the ACF receives from the AFGWC. For each ARAC-serviced site, these data will be stored as hourly reports for the previous 24 h. Any or all of these data can be requested by the operator to be transmitted from the ACF. This option is not yet available, but we plan to include it soon.

REGIONAL MODEL. This function will display the contours of the regional model that the program run at LLL on the 7600's will use. The communication system will update the file that contains the contours, and this function can then be used to overlay the contours on maps with a proper center and scale.

The operator will first select one of the desired model results (Fig. 2), then select the result time range of interest (Fig. 3) by selecting the line number or pointing to the entry desired. Before the time interval is selected, the choice of map must be typed if one is using the keyboard. With the light pen, the operator will select the time and map then point to DISPLAY CONTOURS OVER MAP, and the overlay will be displayed. If PLOT is selected or a <P> typed, printed copy of the contours plotted on the overlay map will be made.

INACTIVE OR PECULIAR KEYBOARD ACTION

There are several ways for the keyboard to malfunction:

OUT OF PAPER. The keyboard is nonresponsive if the printer is out of paper. After replacing the paper, place the keyboard in local and test type a few characters. When placed back on line, it should function normally.

ON-LINE/LOCAL. The keyboard only works with the site system when it is ON LINE.

BAUD-300. The keyboard requires a 300 BAUD line for proper functioning.

REGIONAL MODEL CALCULATIONS

CURRENT T/D 5/ 2/77 21:19

1. INTEGRATED SURFACE AIR

2. GROUND DEPOSITION

3. SURFACE AIR CONCENTRATION

4. DOSE

5.

6.

Fig. 2. Options on the REGIONAL MODEL selection from the MENU.

# 1. INTEGRATED SURFACE AIR			
CURRENT T/D 5/2/77 21:19			
		OBSERVATION VALID	
	DATE	TIME	TIME
# 1.	3/3/76	09:00	10:00
# 2.	3/3/76	00:00	11:00
# 3.	3/3/76	11:00	12:00
# 4.	3/3/76	12:00	13:00
# 5.	X/XX/XX	XX:XX	XX:XX
# 6.	X/XX/XX	XX:XX	XX:XX
# REGIONAL MAP	# TRAJECTORY MAP	# SITE MAP	
# DISPLAY CONTOURS OVER MAP			# EXIT

Fig. 3. Display of INTEGRATED SURFACE AIR from the REGIONAL MODEL showing dates and time ranges for selection.

CAPS LOCK/SHIFT LOCK. If locked in upper case, numbers cannot be entered. This condition is evidenced by red light on the shift key.

STUCK KEY. Occasionally a key may stick, deactivating the keyboard until released.

JOY STICK. The joy stick is part of the keyboard; if it starts to malfunction, the keyboard will also appear to malfunction.

LIGHT PEN

The light pen is an instrument for computing and pointing. When touched with the pen, the desired item will start to blink, indicating that it has been selected. Some words are crowded and contact must be confirmed with a second use of the pen. Although the entire word or line is sensitive to the light pen, the easiest way to select one item is to point to the solid box next to the line. If the screen brightness is too high, the light pen can activate items when several inches from the screen. For this reason, the keyboard might be more useful at times.

SITE SYSTEM RESTART

Restarting (Booting) the Site System

Power off, software halt, hardware failure, halt switch on, system device offline, and system device write protected are all situations that will require restarting the system.

Boot-Key Switch. Using this switch is the preferred method of restarting the system, but there are times it will not work. Before the switch will work, the system device must be mounted, write-enabled and selected to device 0. Deletion of any of these steps will prevent a successful restart. Turning the BOOT switch clockwise will normally cause the system to restart. On some occasions, the operator may have to first turn the switch counterclockwise, then clockwise.

Halt/Start Switch. If booting will not work, using this switch will often work. If the Watch Dog Timer is enabled, then depressing the HALT switch will cause an automatic boot. If the HALT switch is left depressed, nothing will run. The START switch does nothing to restart the

system except for clearing peculiar system memory locations. Therefore, by depressing HALT, depressing START several times, raising HALT and using the boot-key switch, the system will normally restart from almost all system failures that do not require a repairman. The HALT and START switches do not work if the power switch is in LOCK.

Watch Dog Timer. This is a device which runs with the system; if the system fails, this will boot the system. The operator has no control over this. The Watch Dog Timer can hide some failures and makes diagnosing malfunctions difficult.

Powering On/Off. When the power comes on with the ON/OFF/LOCKED switch in ON or LOCKED, it will automatically boot the system. This is one way of restarting to clear one of the above problems; however, turning the switch ON to OFF and then back to ON is not recommended unless all of the above methods have been tried first.

Time and Data

When a boot occurs, the system is automatically started and an introductory message is typed on the console printer. This message consists of an RT-11 VERSION line followed by periods, and a line that reports LOADED AT XXX and more periods. When the console printer stops, the screen will have MONTH in the lower left corner. You should type the month, day, year, hour, and minute following each two digit entry with a carriage return, <CR>. YEAR is the last two digits of current year, and HOUR is Greenwich Mean Time. If a mistake is made and the minutes have not yet been entered, then a line feed command, <LF>, will start the month entry again.

When these tasks are completed, the MENU will appear on the screen. If operator does not enter the time and data, the computer will assume the last 15 min of system time. This explains why with no communications to the ACF, the present system will lose time if no one is present when the Watch Dog Timer restarts it. The present system also does not change the date at the end of each month, and the operator must restart it at this time.

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