EXHIBIT F

MONTHLY GATE EXERCISE

PRADO DAM

SANTA ANA RIVER

RIVERSIDE COUNTY, CALIFORNIA

Los Angeles District Office

U.S. Army Corps of Engineers

September 1991

MONTHLY GATE EXERCISE

PRADO DAM WATER CONTROL MANUAL

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I - PROCEDURE OUTLINE

1-01 Introduction. In order to ensure the operability of the Prado Dam outlet gates, it has been found necessary to periodically (normally monthly) raise and lower (exercise) each gate. When water is impounded at Prado Dam the water control manager must determine the time period between the exercising of each individual gate. These calculations are made to balance the outflow volume of the gate exercise with the outflow volume that would have been discharge without the gate exercise.

IMPORTANT NOTES

> Gates are not to be exercised during Flood Control Operations.
>
> Gates are not to be exercised when the WSE is above 494-ft.
>
> During a gate exercise only one gate is ever open at any one time.

1-02 Procedure. The following three step calculation is used to determine the "time between gate openings" for each individual gate at Prado Dam (See Plate F-01). Note that the "time between gate openings" is **not** the time duration in which a gate is in the open position. During a gate exercise the gate is opened five feet and immediately closed. The "time between gate openings" includes the time that the single gate is opened and closed and a wait period when all gates remain closed. Plate F-01a graphically illustrates the "time between gate openings".

a. Step 1. Determine the instantaneous outflow of a single gate, open to 5.0-ft at the current WSE. Either option 12 of the RESCAL program or the gate rating curves on Plate 2-6a-d can be used to determine the instantaneous outflow.

b. Step 2. Calculate the volume of water released from opening one gate to 5.0-ft and then immediately closing it. Assume the gate can be opened and closed one foot per minute and that the resultant outflow hydrograph has a simple triangular form. The following equation can be used to determine the volume of a single gate opened to 5.0-ft and then immediately closed:

$$V \quad = \quad 0.007 \, (Q_{Inst}) \tag{Eq. F-1}$$

where:

V	=	the outflow volume in ac-ft of opening to 5.0-ft and immediately closing a single gate;
Q_{Inst}	=	the instantaneous outflow in cfs for a single gate open to 5.0-ft at the existing WSE.

    c. Step 3. Determine the "time between gate openings" for each gate using:

$$T \quad = \quad 726 \, (V \, / \, Q_o) \hspace{4cm} \text{(Eq. F-2)}$$

where:

T	=	the "time between gate openings" in minutes for the exercise of one gate. Note this is **not** the duration of time in which the gate is in the open position. The gate is opened to five feet and then immediately closed. See Plate F-01;
V	=	the outflow volume in ac-ft opening to 5.0-ft and immediately closing a single gate as calculated from Eq. F-1;
Q_o	=	the outflow in cfs prior to the gate exercise.

II - EXAMPLE APPLICATION OF A MONTHLY GATE EXERCISE

2-01 Example Problem. The following example assumes that the current WSE at Prado Dam is 493.0-ft and the current outflow from the Dam is 300 cfs.

    a. Step 1. Using option 12 of the RESCAL program the instantaneous outflow for a single gate open to 5.0-ft and a WSE of 493.0-ft is 1,191 cfs.

    b. Step 2. Plate F-01a graphically illustrates the simple triangular hydrograph of opening to 5.0-ft and immediately closing one gate. The outflow volume of this hydrograph can be calculated from Eq. F-1:

$$V \quad = \quad 0.007 \, (1{,}191 \text{ cfs})$$

$$V \quad = \quad 8.3 \text{ ac-ft}$$

    c. Step 3. Plate F-01b graphically illustrates the outflow prior to the gate exercise. To balance the release from the gate exercise with the prior release, it is necessary to determine the length of time that a 300 cfs release would take to equal 8.3 ac-ft. Eq. F-2 can be used to determine this length of time:

$$T \quad = \quad 726 \, (\, 8.3 \text{ ac-ft} \, / \, 300 \text{ cfs})$$

$$T \quad = \quad 20.1 \text{ minutes}$$

    Therefore the "time between gate openings" for exercising each individual gate is 20 minutes. The dam tender will start timing the gate exercise at the time the gate is opened. The gate is opened to five feet and then immediately closed. The dam tender will then wait until 20 minutes have passed before exercising the next gate or returning to the original gate settings. Plate F-01a illustrates this example gate exercise.
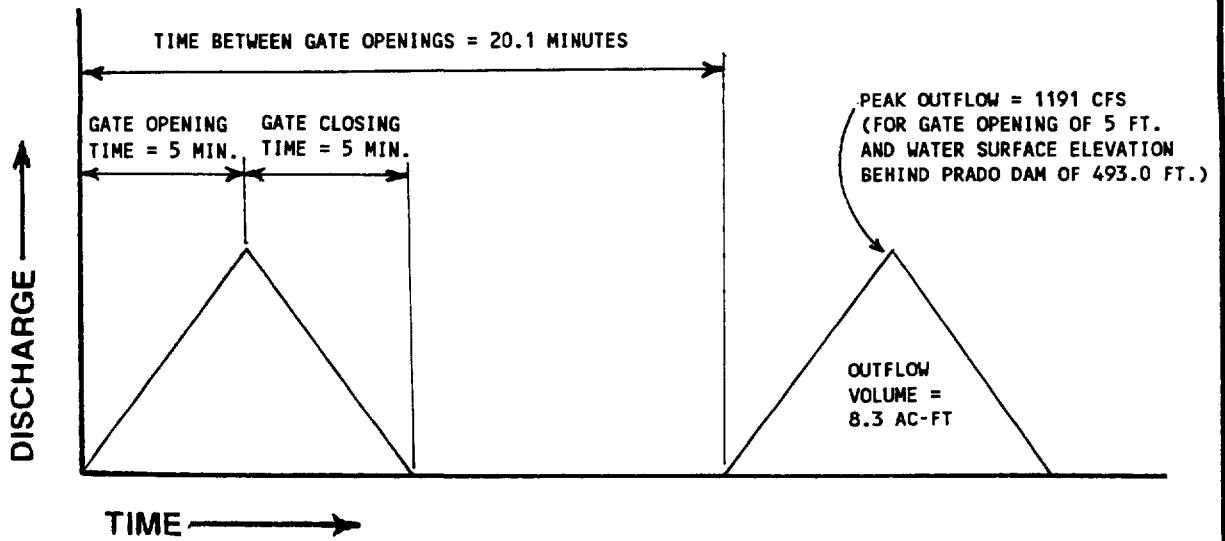
TIME BETWEEN GATE OPENINGS = 20.1 MINUTES

PEAK OUTFLOW = 1191 CFS
(FOR GATE OPENING OF 5 FT.
AND WATER SURFACE ELEVATION
BEHIND PRADO DAM OF 493.0 FT.)

GATE OPENING   GATE CLOSING
TIME = 5 MIN.   TIME = 5 MIN.

DISCHARGE

OUTFLOW
VOLUME =
8.3 AC-FT

TIME

PLATE F-01a OUTFLOW DURING GATE EXERCISE

DISCHARGE

CURRENT OUTFLOW = 300 CFS
(CORRESPONDS TO WATER SURFACE ELEVATION BEHIND PRADO DAM OF 493.0 FT.)

OUTFLOW VOLUME = 8.3 AC-FT
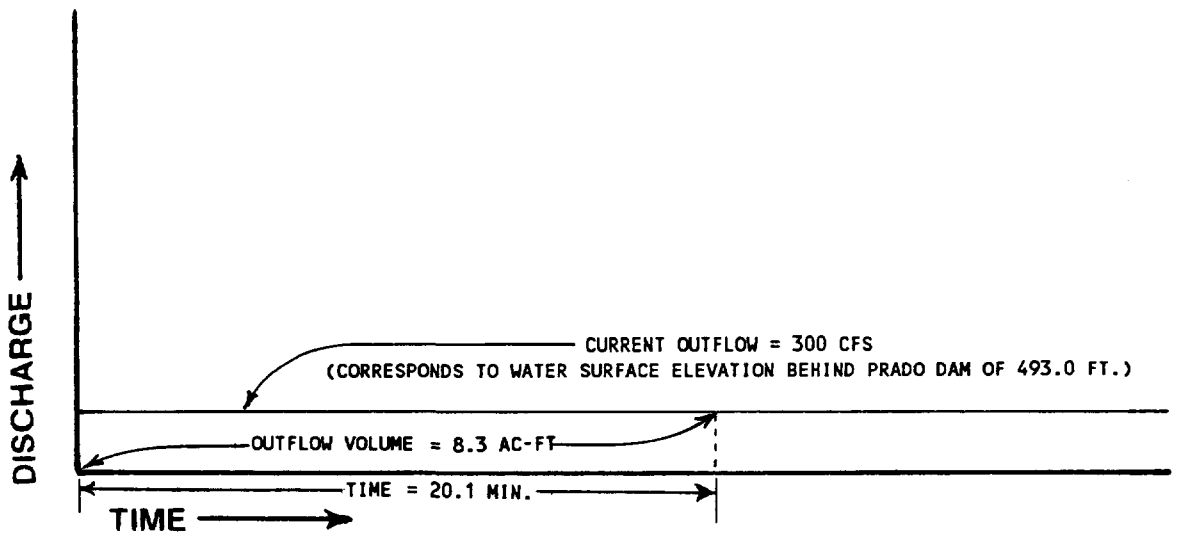
TIME = 20.1 MIN.

TIME

PLATE F-01b   OUTFLOW PRIOR TO GATE EXERCISE

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| WATER CONTROL MANUAL |
| EXAMPLE APPLICATION |
| OF A MONTHLY GATE EXERCISE |
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| LOS ANGELES DISTRICT |

PLATE F-01