II.4-RES-SNGL-A-FILLSPILL SINGLE RESERVOIR REGULATION OPERATION
                          SCHEME FILL AND SPILL

Description

Scheme FILLSPILL allows the reservoir to pass inflow, meet minimum
downstream flow requirements or to fill until a specified pool
elevation is reached.

Inflow is passed if it is less than a specified limiting discharge
(QLIM) and greater than the minimum flow required downstream. The
limiting discharge is imposed by the dam facilities or by the
reservoir operation rules. For a power dam the limiting discharge
would be the maximum generation discharge. For a non-power dam the
limiting discharge would be the minimum reservoir release requirement
or the maximum sluice discharge depending on the reservoir operating
rules. When inflow exceeds the limiting discharge the pool is
allowed to fill until the specified pool elevation is reached. In
general the specified pool elevation would be at about 0.5 feet below
the top of a closed gate (PASSEL) for a gated spillway and at the
spillway crest for an uncontrolled spillway (CREST). If inflow is
not sufficient to meet minimum downstream flow requirements the pool
elevation falls.

At the specified pool elevation the operation rules are to pass as
much inflow as possible in order to keep the pool level down. Gates
or other facilities are assumed to be able to open or close as
required to pass inflow. Therefore this specified pool elevation is
named the pass inflow elevation (PASSEL). Inflow will be passed at
the pass inflow elevation until the maximum possible discharge
(QPASMX is exceeded. QPASMX is the maximum possible discharge
capacity through fully open gates and other facilities of a dam while
pool is at the specified elevation. When inflow exceeds the maximum
possible discharge QPASMX routing over the spillway is required.
Methods of routing are given in the SPILLWAY Scheme.

First the reservoir storage at the pass inflow elevation (SPASSI) is
determined from the storage versus elevation curve, V = v(H).

For a gated spillway:

   SPASSI = V(PASSEL)

and for an uncontrolled spillway:

   SPASSI = C(CREST)

The FILLSPILL Scheme involves 3 different processes:

   1. FILL if V1 < SPASSI

   2. PASS inflow if V1=SPASSI

   3. SPILL if V1 > SPASSI

1. FILL if V1 < SPASSI

In this case the pool elevation is below the pass inflow elevation.
Under normal operation conditions the operation rule is to maintain a
minimum release as dictated by the power generation requirement
and/or the downstream minimum flow requirement. As the inflow
changes the operation rules can be shown in Figure 1. Keep in mind
the pool elevation is below the pass inflow elevation.

Inflow will be passed by opening or closeing the turbine wicket gate
and/or the sluice gate if it is less than the limiting discharge.
Otherwise the reservoir release is equal to the limiting discharge
and the reservoir is allowed to fill:

    QOM' = AMIN1 (QIM,QLIM)
    QO_2' = AMIN1 (QI_2,QLIM)

In case inflow reduces to below the minimum permissible flow the
minimum reservoir release will be maintained to satisfy the needs of
downstream sites. The minimum reservoir release may be power
generation discharge (QGEN) or sluice discharge (QSLUICE) or both:

    QOK = QGEN + QSLUICE
    QOM = AMAX1 (QOM',QOKM)
    QO_2 = AMAX1 (QO_2',QOK_2)

It should be noted that QGEN + QSLUICE is limited by QLIM.

The reservoir storage is then computed from the continuity equation.

    V_2 = V_1 + (QIM – QOM) * data_time_interval

If computed V_2 > SPASSI then the reservoir has reached the pass inflow
elevation.

2. PASS inflow if V1=SPASSI

At the pass inflow elevation the ability to pass inflow is governed
by QPASMX. QPASMX is the maximum discharge capacity through fully
open gates and other facilities of the dam. QPASMX consists of
maximum spillway discharge (SPILMX) and maximum nonspillway discharge
(QLIM). If power generation discharge is not effected by tailwater
then SPILMAX at the pass inflow elevation is determined from the
spillway rating curve, QS=qs(H):

    SPILMX = qs(PASSEL)

    and

    QPASMX = SPILMX + QLIM

If power generation discharge is effected by tailwater then QPASMX is
determined directly from the total discharge versus pool elevation
curve. An iterative method is required to generate the total
discharge versus pool elevation curve and is given in the SPILLWAY
Scheme.

Assume the dam is capable of passing inflow then:

V_2 = SPASSI

QOM = (V_1 - SPASSI) / data_time_interval + QIM

QO_2 = QI_2

If QI_2 > QPASSMX or QOM > QPASSMX then routing over spillway is required. Methods of routing are given in the SPILLWAY Scheme.

3. SPILL if V_1 > SPASSI

In general the dam operator will allow the pool storage to exceed SPASSI without routing if the following conditions are met:

QI_1, QI_2 and $QO_1 \leq$ QPASMX

then

QOM = AMIN1 (QIM, QLIM)

QO_2 = AMIN1 (QI_2, QLIM)

V_2 = V_1 + (QIM - QOM) * data_time_interval

Otherwise routing over the spillway is required. Methods of routing are given in the SPILLWAY Scheme.

Figure 1. Operation rules as inflow changes

QI

QO=QLIM

Maximum release limited
by QLI

QLIM

Dam Opereator opens or closes
turbine wicket gate and/or
sluice gate to pass inflow

QO=QI

QOK

Minimum release dictated
by power generation and/or
downstream minimum requirement

QO=QOK