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 closing 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:

\[ Q_{O1}' = \text{AMIN1} (Q_{IM}, Q_{LIM}) \]
\[ Q_{O2}' = \text{AMIN1} (Q_{I2}, Q_{LIM}) \]

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:

\[ Q_{OK} = Q_{GEN} + Q_{SLUICE} \]
\[ Q_{OM} = \text{AMAX1} (Q_{O1}', Q_{OKM}) \]
\[ Q_{O2} = \text{AMAX1} (Q_{O2}', Q_{OK2}) \]

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

The reservoir storage is then computed from the continuity equation.

\[ V_2 = V_1 + (Q_{IM} - Q_{OM}) \times \text{data_time_interval} \]

If computed \( V_2 > \text{SPASSI} \) 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, \( QS=qs(H) \):

\[ \text{SPILMX} = qs(\text{PASSEL}) \]

and

\[ \text{QPASMX} = \text{SPILMX} + QLIM \]

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:

\[ V_2 = \text{SPASSI} \]

\[ QOM = \frac{(V_1 - \text{SPASSI})}{\text{data\_time\_interval}} + QIM \]

\[ QO_2 = QI_2 \]

If \( QI_2 > \text{QPASSMX} \) or \( QOM > \text{QPASSMX} \) then routing over spillway is required. Methods of routing are given in the SPILLWAY Scheme.

3. **SPILL if \( V_1 > \text{SPASSI} \)**

In general the dam operator will allow the pool storage to exceed \( \text{SPASSI} \) without routing if the following conditions are met:

\( QI_1, QI_2 \) and \( QO_1 \leq \text{QPASMX} \)  

then

\[ QOM = \text{AMIN1} (QIM, QLIM) \]

\[ QO_2 = \text{AMIN1} (QI_2, QLIM) \]

\[ V_2 = V_1 + (QIM - QOM) \times \text{data\_time\_interval} \]

Otherwise routing over the spillway is required. Methods of routing are given in the SPILLWAY Scheme.
Figure 1. Operation rules as inflow changes

- **QI**: Maximum release limited by QI
- **QO=QLIM**: Dam operator opens or closes turbine vicket gate and/or sluice gate to pass inflow
- **QO=QI**: Minimum release dictated by power generation and/or downstream minimum requirement