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TITLE

PERMISSIBLE LIMITS - RELEASE OF [illegible] EFFLUENT TO THE COLUMBIA RIVER

AUTHOR

H. M. Parker

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PERMISSIBLE LIMITS – RELEASE OF REACTOR EFFLUENT TO THE COLUMBIA RIVER

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H. M. Parker

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C.N. GROSS, MANAGER
MANUFACTURING DEPARTMENT

This document consists of
6 pages
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Richland, Washington
May 6, 1952

SUBJECT: PERMISSIBLE LIMITS - RELEASE OF REACTOR EFFLUENT TO THE COLUMBIA RIVER

1. History of the Problem

At the time that the Hanford reactors were first energized, appropriate limits for the radioactivity of the effluent water to be returned to the Columbia River were not known.

It was elected to control the waters by the stipulation that the immersion dose rate at the point of release to the river should not exceed 100 mrep per 24 hours or 4.17 mrep per hour, the then existing conventional limit for external exposure. Note that if the same basis were used today, the appropriate limit would be 1.78 mrep per hour (based on 300 mrep per week to a small organism). *

[redacted]

* There is another small hidden change in here. Originally the "rep" implied an energy absorption dose of 83 ergs/gm. Throughout the rest of this report, we imply 1 rep = 93 ergs/gm in tissue, which for all practical purposes is the same as 93 ergs/gm in water.

[redacted]

It was recognized from the start that a realistic limit would have to be based on a knowledge of other radiobiological consequences in the river. These were almost completely unpredictable, except as to gross order of magnitude. In effect, we implied that the immersion dose limit was highly conservative because of the prompt dilution in the river, but that biological concentration factors would approximately compensate for primary dilution. It is now known that such factors could more than outweigh the dilution under some conditions, although this would normally not be the case.

Concurrent with the establishment of the original limit, such investigation programs as were possible in the stress of wartime conditions were initiated. It is important to appreciate that a program fully adequate to resolve the problems was not begun until the original "no research" attitude at the Hanford Works was replaced by the enlightened encouragement of the present management to conduct research appropriate to the solution of local problems. Such studies are now proceeding at an adequate pace, although full solutions cannot be expected immediately.

As a result of early appraisal of incomplete results, the original limit was raised to 10 mrep/hr, with a reminder that final control is conditioned by biological investigation (C.M. Patterson to E.P. Lee, "Retention Basin Effluent", March 31, 1949). This revision appears to have been incorporated in your operating standards.

A later communication (J.M. Smith to K.T. Perkins, "Sizing of Retention Basin 107-C", March 7, 1951) states in part:

"The arbitrarily selected upper limit of 10 mrep/hr on 107 effluent activity is considered to have little practical meaning. No dilution at the flume will be recommended as the benefits derived are small compared with the immediate dilution obtained upon discharge into the river. Possible hazards to river life are dependent primarily on the total amount of longer-lived activities released."

Apparently this opinion has been applied only to development of 107-C basin criteria.

Present Position

No realistic limit in terms of immersion dose rate exists, except that there is some upper limit that would inevitably apply after dilution in the river. This is higher than limits contemplated for other reasons.

No realistic limit in terms of gross effluent activity density (μc/cc) exists, although an appropriate limit could be developed for an effluent of known and invariant radiochemical content. The appropriate limit is a function of the total operating power level, the retention time, river conditions, and effluent water composition. The limit is particularly sensitive to the radiochemical composition; the numerous reports that certain

proposed changes in influent water composition reduce the effluent activity are misleading for purposes of waste disposal study. All concerned with the problem should appreciate that it is possible to reduce the effluent activity and simultaneously increase the actual radiation hazard.

Proposed changes in water treatment will require close study by the Radiological Sciences Department to determine the effect in the river. Furthermore, the McNary Dam impoundment may change earlier conclusions about the adequacy of the disposal system.

At the present time, we have the following opinions:

1. Immersion dose-rate is the readiest guide to operating practice, but is not the real determinant. It is a useful guide if water treatment is essentially unchanged.

2. Retention time may be safely reduced, provided that auxiliary means are available to divert ruptured slug debris from the effluent stream which goes to the river. * For this reason, the C.T. Main proposal for batch release to the river is considered preferable to the present practice.

3. Major changes in water treatment will require close examination (after the fact) by Radiological Sciences.

4. All changes in effluent release will have to be discussed with the Columbia River Advisory Group.

5. For an immediate problem at the 100-F Area, the sharp increment in effluent activity seems to be mainly due to Mn^{56}, which is one of the less hazardous components.

6. In the final analysis, there may be two sets of testing criteria, - one applicable to river water as it leaves the reservation and governed mainly by the content of long-lived activities, - the other applicable to local conditions around the injection points in the river, and governed mainly by immersion dose-rate or gross activity density at release. We believe that the first set of criteria are applicable today. Foreseen changes in water treatment and retention time may drive the situation to the second case. This is a primary justification for continuing the immersion dose-rate measurements.

7. Only if the second case applied would there by any gain by dilution of the effluent. In all other cases, the total quantity of each specific radioisotope released is probably the significant factor.

* With the reservation that our preliminary tests on this point are somewhat contrary to expectations and require additional study.

8. Subsequent changes in national recommendations or the publication of firm A.E.C. regulations on waste disposal may lead to sharp revisions of release practice. However, the most recent draft of proposed A.E.C. regulations has taken cognizance of most of this department's objections to the 1951 draft.

Current Recommendations

1. As an assist to safe waste disposal, the addition of water to the effluent stream is probably valueless and should be discontinued.

2. Although there is no firm upper limit for immersion dose-rate, an operating limit of 15 mrep/hr should be maintained.

3. The immersion dose-rate limit may be interpreted to be met by a 24-hour total dose of 360 mrep, provided that the dose in any one hour does not exceed 50 mrep.

4. Continuous gamma radiation monitoring of effluent activity should be maintained.

5. The beta radiation component of immersion dose-rate shall be measured in apparatus sensitive to soft beta radiation, (windows equivalent to 3 mg/cm^2 or less as in a conventional mica window counter).

6. Continuous beta radiation monitoring is desirable, whenever instrumentation suitable for such operation is developed. If done with apparatus of relatively thick wall (for example, about 30 mg/cm^2), the continuous monitoring should be supplemented by occasional checks for soft beta emitters.

7. Without continuous beta monitoring, spot samples should be recorded on a schedule as follows:

   (a) once per 24 hours if the normal beta component is below 3 mrep/hr.

   (b) once per 8 hours if the normal beta component is between 3 and 6 mrep/hr.

   (c) hourly, if the beta component is above 6 mrep/hr and in all cases, additional samples following purges, slug ruptures, or other unusual conditions.

8. In the event that the above conditions are not met, the Head-Radiation Standards, Radiological Records and Standards Section, should be advised promptly, and his temporary recommendations accepted. *

* Alternate notification in his absence shall be:
  1. Manager - Radiological Records and Standards Section
  2. Staff Engineer, Exposure Investigations
  3. Director, Radiological Sciences Department

9. In the event that the immersion dose in one hour exceeds 100 mrep, the reactor should be shut down until appropriate investigation has been made.

10. In the event that the ratio of beta dose-rate / gamma dose-rate in any one retention basin system deviates from its normal value by more than a factor of two, notification should proceed as in item #8.

11. Whenever a ruptured slug is detected, the water from the affected tube should be diverted to a crib with a suitable absorbing layer, as promptly as possible.

12. Notification as in item #8 should be given whenever there is a significant change in the preparation of reactor influent water. By "significant change" is meant such steps as basic change in flocculation process, omission of a formerly used chemical (e.g., dichromate), or addition of a new chemical. The normal changes in quantities, arising from correction of varying river turbidity and the like, and regular purges, are not intended to be covered.

Future Outlook

Changes in these recommendations can be expected to occur as a result of changes in national or A.E.C. regulations. The McNary impoundment will tend to require reduced limits.

Reduction in retention time by adoption of the C.T. Main batch disposal method, which is favored by this department, could lead to higher operating immersion dose limits.

We are much concerned about the quantities of fission products, as differentiated from activation products which go to the river. This arises from the chance occurrence that fission products may be significantly more hazardous per rep than are the particular activation products in reactor effluent in past experience at Hanford.

Fission products may arise from five sources:

(a) Fission of natural uranium and other natural constituents of Columbia River water.

(b) Fission of additional uranium escaping from an upstream reactor and being drawn into a downstream one.

(c) Fission of uranium introduced as contamination on the surfaces of slugs.

(d) Fission products escaping through intact slug jackets.

(e) Gross release from ruptured slugs.

These factors are currently being investigated as to relative importance. We expect that item (c) will be significant, and that improvement in waste disposal may be effected by careful cleaning of slugs. There is an obvious common interest in eliminating item (e).

Current disposal practice increases the river temperature to a point which is conceivably critical in the month of October. Batch disposal and particularly future increments of power level will aggravate the condition. It is conceivable that we may recommend reduced power levels for a period of perhaps two weeks in each year. It would be appropriate for you to determine the feasibility of scheduling major shut downs for repair for such periods.

Purpose of this Document

It is not the intent of this document to issue to the Manufacturing Department a set of mandatory regulations for control of effluent activity. Rather it is the purpose first to review briefly the background of the Radiological Sciences Department problem of determining the adequacy of the waste disposal system - and secondly to propose a set of recommendations that should offer a working code of minimum interference with production, while at the same time providing necessary safeguards by prompt referral of unusual conditions to us.

We would appreciate your careful study of these recommendations. If they are broadly acceptable in present form, this could be so indicated by letter to me, and this document made the reference document in your revised operating standards.

If substantial changes seem to be appropriate, the expedient course would be to arrange a discussion between interested members of Manufacturing and Radiological Sciences organizations, after which a revised recommendation, without repetition of the other sections of this document could be issued by us.

H M Parker

Director
RADIOLOGICAL SCIENCES DEPARTMENT

HM Parker:swc