REPORTS OF INTERNATIONAL ARBITRAL AWARDS

RECUEIL DES SENTENCES ARBITRALES

Trail smelter case (United States, Canada)

16 April 1938 and 11 March 1941

VOLUME III pp. 1905-1982
TRAIL SMELTER CASE.

PARTIES: United States of America, Canada.

SPECIAL AGREEMENT: Convention of Ottawa, April 15, 1935.

ARBITRATORS: Charles Warren (U.S.A.), Robert A. E. Green-shields (Canada), Jan Frans Hostie (Belgium).

AWARD: April 16, 1938, and March 11, 1941.

Canadian company.—Smelter operated in Canada.—Fumes.—Damages caused on United States territory.—Recourse to arbitration.—Date of damages.—Evidence.—Cause.—Effect.—Indirect and remote damage.—Violation of Sovereignty.—Interpretation of Special Agreement as to scope.—Preliminary correspondence.—Interest.—Future régime applicable.—Appointment of technical consultants.—Law applicable.—National law.—Matters of procedure.—Convention, Article IV.—Reference to American law.—Provisional decision.—Certain questions finally settled.—Res judicata.—Error in law.—Admissibility of revision.—Powers of tribunal.—Discovery of new facts.—Denial.—Costs of investigation.—Claim for indemnity.—Such costs no part of damage.—Claim for request to stop the nuisance.—Law applicable.—Coincidence of national and international laws.—Responsibility of States.—Air and water pollution.—Protection of sovereignty.—Institution of régime to prevent future damages.—Indemnity or compensation on account of decision or decisions rendered.

1 For bibliography, index and tables, see end of this volume.
Special agreement.

CONVENTION FOR SETTLEMENT OF DIFFICULTIES ARISING FROM OPERATION OF SMELTER AT TRAIL, B.C. ¹

Signed at Ottawa, April 15, 1935; ratifications exchanged Aug. 3, 1935

The President of the United States of America, and His Majesty the King of Great Britain, Ireland and the British dominions beyond the Seas, Emperor of India, in respect of the Dominion of Canada,

Considering that the Government of the United States has complained to the Government of Canada that fumes discharged from the smelter of the Consolidated Mining and Smelting Company at Trail, British Columbia, have been causing damage in the State of Washington, and

Considering further that the International Joint Commission, established pursuant to the Boundary Waters Treaty of 1909, investigated problems arising from the operation of the smelter at Trail and rendered a report and recommendations thereon, dated February 28, 1931, and

Recognizing the desirability and necessity of effecting a permanent settlement,

Have decided to conclude a convention for the purposes aforesaid, and to that end have named as their respective plenipotentiaries:

The President of the United States of America:

PIERRE DE L. BOAL, Chargé d’Affaires ad interim of the United States of America at Ottawa;

His Majesty the King of Great Britain, Ireland and the British dominions beyond the Seas, Emperor of India, for the Dominion of Canada:

The Right Honorable RICHARD BEDFORD BENNETT, Prime Minister, President of the Privy Council and Secretary of State for External Affairs;

Who, after having communicated to each other their full powers, found in good and due form, have agreed upon the following Articles:

ARTICLE I.

The Government of Canada will cause to be paid to the Secretary of State of the United States, to be deposited in the United States Treasury, within three months after ratifications of this convention have been exchanged, the sum of three hundred and fifty thousand dollars, United States currency, in payment of all damage which occurred in the United States, prior to the first day of January, 1932, as a result of the operation of the Trail Smelter.

ARTICLE II.

The Governments of the United States and of Canada, hereinafter referred to as "the Governments", mutually agree to constitute a tribunal hereinafter referred to as "the Tribunal", for the purpose of deciding the questions

¹ U. S. Treaty Series No. 893.
referred to it under the provisions of Article III. The Tribunal shall consist of a chairman and two national members.

The chairman shall be a jurist of repute who is neither a British subject nor a citizen of the United States. He shall be chosen by the Governments, or, in the event of failure to reach agreement within nine months after the exchange of ratifications of this convention, by the President of the Permanent Administrative Council of the Permanent Court of Arbitration at The Hague described in Article 49 of the Convention for the Pacific Settlement of International Disputes concluded at The Hague on October 18, 1907.

The two national members shall be jurists of repute who have not been associated, directly or indirectly, in the present controversy. One member shall be chosen by each of the Governments.

The Governments may each designate a scientist to assist the Tribunal.

**Article III.**

The Tribunal shall finally decide the questions, hereinafter referred to as "the Questions", set forth hereunder, namely:

1. Whether damage caused by the Trail Smelter in the State of Washington has occurred since the first day of January, 1932, and, if so, what indemnity should be paid therefor?
2. In the event of the answer to the first part of the preceding Question being in the affirmative, whether the Trail Smelter should be required to refrain from causing damage in the State of Washington in the future and, if so, to what extent?
3. In the light of the answer to the preceding Question, what measures or régime, if any, should be adopted or maintained by the Trail Smelter?
4. What indemnity or compensation, if any, should be paid on account of any decision or decisions rendered by the Tribunal pursuant to the next two preceding Questions?

**Article IV.**

The Tribunal shall apply the law and practice followed in dealing with cognate questions in the United States of America as well as international law and practice, and shall give consideration to the desire of the high contracting parties to reach a solution just to all parties concerned.

**Article V.**

The procedure in this adjudication shall be as follows:

1. Within nine months from the date of the exchange of ratifications of this agreement, the Agent for the Government of the United States shall present to the Agent for the Government of Canada a statement of the facts, together with the supporting evidence, on which the Government of the United States rests its complaint and petition.
2. Within a like period of nine months from the date on which this agreement becomes effective, as aforesaid, the Agent for the Government of Canada shall present to the Agent for the Government of the United States a statement of the facts, together with the supporting evidence, relied upon by the Government of Canada.
3. Within six months from the date on which the exchange of statements and evidence provided for in paragraphs 1 and 2 of this article has been com-
pleted, each Agent shall present in the manner prescribed by paragraphs 1 and 2 an answer to the statement of the other with any additional evidence and such argument as he may desire to submit.

**Article VI.**

When the development of the record is completed in accordance with Article V hereof the Governments shall forthwith cause to be forwarded to each member of the Tribunal a complete set of the statements, answers, evidence and arguments presented by their respective Agents to each other.

**Article VII.**

After the delivery of the record to the members of the Tribunal in accordance with Article VI the Tribunal shall convene at a time and place to be agreed upon by the two Governments for the purpose of deciding upon such further procedure as it may be deemed necessary to take. In determining upon such further procedure and arranging subsequent meetings, the Tribunal will consider the individual or joint requests of the Agents of the two Governments.

**Article VIII.**

The Tribunal shall hear such representations and shall receive and consider such evidence, oral or documentary, as may be presented by the Governments or by interested parties, and for that purpose shall have power to administer oaths. The Tribunal shall have authority to make such investigations as it may deem necessary and expedient, consistent with other provisions of this convention.

**Article IX.**

The Chairman shall preside at all hearings and other meetings of the Tribunal and shall rule upon all questions of evidence and procedure. In reaching a final determination of each or any of the Questions, the Chairman and the two members shall each have one vote, and, in the event of difference, the opinion of the majority shall prevail, and the dissent of the Chairman or member, as the case may be, shall be recorded. In the event that no two members of the Tribunal agree on a question, the Chairman shall make the decision.

**Article X.**

The Tribunal, in determining the first question and in deciding upon the indemnity, if any, which should be paid in respect to the years 1932 and 1933, shall give due regard to the results of investigations and inquiries made in subsequent years.

Investigators, whether appointed by or on behalf of the Governments, either jointly or severally, or the Tribunal, shall be permitted at all reasonable times to enter and view and carry on investigations upon any of the properties upon which damage is claimed to have occurred or to be occurring, and their reports may, either jointly or severally, be submitted to and received by the Tribunal for the purpose of enabling the Tribunal to decide upon any of the Questions.
ARTICLE XI.

The Tribunal shall report to the Governments its final decisions, together with the reasons on which they are based, as soon as it has reached its conclusions in respect to the Questions, and within a period of three months after the conclusions of proceedings. Proceedings shall be deemed to have been concluded when the Agents of the two Governments jointly inform the Tribunal that they have nothing additional to present. Such period may be extended by agreement of the two Governments.

Upon receiving such report, the Governments may make arrangements for the disposition of claims for indemnity for damage, if any, which may occur subsequently to the period of time covered by such report.

ARTICLE XII.

The Governments undertake to take such action as may be necessary in order to ensure due performance of the obligations undertaken hereunder, in compliance with the decision of the Tribunal.

ARTICLE XIII.

Each Government shall pay the expenses of the presentation and conduct of its case before the Tribunal and the expenses of its national member and scientific assistant.

All other expenses, which by their nature are a charge on both Governments, including the honorarium of the neutral member of the Tribunal, shall be borne by the two Governments in equal moieties.

ARTICLE XIV.

This agreement shall be ratified in accordance with the constitutional forms of the contracting parties and shall take effect immediately upon the exchange of ratifications, which shall take place at Ottawa as soon as possible.

In witness whereof, the respective plenipotentiaries have signed this convention and have hereunto affixed their seals.

Done in duplicate at Ottawa this fifteenth day of April, in the year of our Lord, one thousand, nine hundred and thirty-five.

[seal] Pierre de L. Boal.

TRAIL SMELTER ARBITRAL TRIBUNAL.

DECISION


This Tribunal is constituted under, and its powers are derived from and limited by, the Convention between the United States of America and the Dominion of Canada signed at Ottawa, April 15, 1935, duly ratified by the two parties, and ratifications exchanged at Ottawa, August 3, 1935 (hereinafter termed "the Convention").

By Article II of the Convention, each Government was to choose one member of the Tribunal, "a jurist of repute", and the two Governments were to choose jointly a Chairman who should be a "jurist of repute and neither a British subject nor a citizen of the United States".

The members of the Tribunal were chosen as follows: by the United States of America, Charles Warren of Massachusetts; by the Dominion of Canada, Robert A. E. Greenshields of the Province of Quebec; by the two Governments jointly, Jan Frans Hostie of Belgium.

Article II, paragraph 4, of the Convention provided that "the Governments may each designate a scientist to assist the Tribunal"; and scientists were designated as follows: by the United States of America, Reginald S. Dean of Missouri; and by the Dominion of Canada, Robert E. Swain of California. The Tribunal desires to record its appreciation of the valuable assistance received by it from these scientists.

The duty imposed upon the Tribunal by the Convention was to "finally decide" the following questions:

(1) Whether damage caused by the Trail Smelter in the State of Washington has occurred since the first day of January, 1932, and, if so, what indemnity should be paid therefor?

(2) In the event of the answer to the first part of the preceding question being in the affirmative, whether the Trail Smelter should be required to refrain from causing damage in the State of Washington in the future and, if so, to what extent?

(3) In the light of the answer to the preceding question, what measures or régime, if any, should be adopted or maintained by the Trail Smelter?

(4) What indemnity or compensation, if any, should be paid on account of any decision or decisions rendered by the Tribunal pursuant to the next two preceding questions?
In 1896, a smelter was started under American auspices near the locality known as Trail, B.C. In 1906, the Consolidated Mining and Smelting Company of Canada, Limited, obtained a charter of incorporation from the Canadian authorities, and that company acquired the smelter plant at Trail as it then existed. Since that time, the Canadian company, without interruption, has operated the Smelter, and from time to time has greatly added to the plant until it has become one of the best and largest equipped smelting plants on the American continent. In 1925 and 1927, two stacks of the plant were erected to 409 feet in height and the Smelter greatly increased its daily smelting of zinc and lead ores. This increased production resulted in more sulphur dioxide fumes and higher concentrations being emitted into the air. In 1916, about 5,000 tons of sulphur per month were emitted; in 1924, about 4,700 tons; in 1926, about 9,000 tons—an amount which rose near to 10,000 tons per month in 1930. In other words, about 300-350 tons of sulphur were being emitted daily in 1930. (It is to be noted that one ton of sulphur is substantially the equivalent of two tons of sulphur dioxide or $\text{SO}_2$.)

From 1925, at least, to 1937, damage occurred in the State of Washington, resulting from the sulphur dioxide emitted from the Trail Smelter as stated in the previous decision.

The subject of fumigations and damage claimed to result from them was referred by the two Governments on August 7, 1928, to the International Joint Commission, United States and Canada, under Article IX of the Convention of January 11, 1909, between the United States and Great Britain, providing that the high contracting parties might agree that "any other question or matters of difference arising between them involving the rights, obligations or interests of either in relation to the other, or to the inhabitants of the other, along the common frontier between the United States and the Dominion of Canada shall be referred from time to time to the International Joint Commission for examination and report. Such reports shall not be regarded as decisions of the question or matters so submitted either on the facts or on the law, and shall not, in any way, have the character of an arbitral award."

The questions referred to the International Joint Commission were five in number, the first two of which may be noted: first, the extent to which property in the State of Washington has been damaged by fumes from the Smelter at Trail B.C.; second, the amount of indemnity which would compensate United States' interests in the State of Washington for past damages.

The International Joint Commission sat at Northport, at Nelson, B.C., and in Washington, D.C., in 1928, 1929 and 1930, and on February 28, 1931, rendered a unanimous report which need not be considered in detail.

After outlining the plans of the Trail Smelter for extracting sulphur from the fumes, the report recommended (Part I, Paragraphs (a) and (c)) that "the company be required to proceed as expeditiously as may be reasonably possible with the works above referred to and also to erect with due dispatch such further sulphuric acid units and take such further or other action as may be necessary, if any, to reduce the amount and concentration of $\text{SO}_2$ fumes drifting from its said plant into the United States until it has reduced the amount by some means to a point where it will do no damage in the United States".
The same Part I, Paragraph (g) gave a definition of "damage":

The word "damage", as used in this document shall mean and include such damage as the Governments of the United States and Canada may deem appreciable, and for the purposes of paragraphs (a) and (c) hereof, shall not include occasional damage that may be caused by SO$_2$ fumes being carried across the international boundary in air pockets or by reason of unusual atmospheric conditions. Provided, however, that any damage in the State of Washington howsoever caused by said fumes on or after January 1, 1932, shall be the subject of indemnity by the company to any interests so damaged.

Paragraph 2 read, in part, as follows:

In view of the anticipated reduction in sulphur fumes discharged from the smelter at Trail during the present year, as hereinafter referred to, the Commission therefore has deemed it advisable to determine the amount of indemnity that will compensate United States interests in respect to such fumes, up to and including the first day of January, 1932. The Commission finds and determines that all past damages and all damages up to and including the first day of January next, is the sum of $350,000. Said sum, however, shall not include any damage occurring after January 1, 1932.

This report failed to secure the acceptance of both Governments. A sum of $350,000 has, however, been paid by the Dominion of Canada to the United States.

Two years after the filing of the above report, the United States Government, on February 17, 1933, made representations to the Canadian Government that existing conditions were entirely unsatisfactory and that damage was still occurring and diplomatic negotiations were entered into which resulted in the signing of the present Convention.

The Consolidated Mining and Smelting Company of Canada, Limited, proceeded after 1930 to make certain changes and additions in its plant, with the intention and purpose of lessening the sulphur contents of the fumes, and in an attempt to lessen injurious fumigations, a new system of control over the emission of fumes during the crop growing season came into operation about 1934. To the three sulphuric acid plants in operation since 1932, two others have recently been added. The total capacity is now of 600 tons of sulphuric acid per day, permitting, if these units could run continually at capacity, the fixing of approximately 200 tons of sulphur per day. In addition, from 1936, units for the production of elemental sulphur have been put into operation. There are at present three such units with a total capacity of 140 tons of sulphur per day. The capacity of absorption of sulphur dioxide is now 600 tons of sulphur dioxide per day (300 tons from the zinc plant gases and 300 tons from the lead plant gases). As a result, the maximum possible recovery of sulphur dioxide, with all units in full operation has been brought to a figure which is about equal to the amount of that gas produced by smelting operations at the plant in 1939. However, the normal shut-down of operating units for repairs, the power supply, ammonia available, and the general market situation are factors which influence the amount of sulphur dioxide treated.

In 1939, 360 tons, and in 1940, 416 tons, of sulphur per day were oxidized to sulphur dioxide in the metallurgical processes at the plant. Of the above,
for 1939, 253 tons, and for 1940, 289 tons per day, of the sulphur which was oxidized to sulphur dioxide was utilized. One hundred and seven tons

### NORTHPORT

(Fumigations in Hours and Minutes at the Concentrations Noted in First Column)

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and 127 tons of sulphur per day for those two years, respectively, were emitted as sulphur dioxide to the atmosphere.

The tons of sulphur emitted into the air from the Trail Smelter fell from about 10,000 tons per month in 1930 to about 7,200 tons in 1931 and 3,400 tons in 1932 as a result both of sulphur dioxide beginning to be absorbed and of depressed business conditions. As depression receded, this monthly average rose in 1933 to 4,000 tons, in 1934 to nearly 6,300 tons and in 1935 to 6,800 tons. In 1936, however, it had fallen to 5,600 tons; in 1937, it further fell to 4,850 tons; in 1938, still further to 4,230 tons to reach 3,250 tons in 1939. It rose again, however, to 3,875 tons in 1940.

During the period since January 1, 1932, automatic recorders for registering the presence of sulphur dioxide in the air, as well as the length of fumigations and the maximum concentration in parts per million (p.p.m.) and one hundredth of parts per million, were maintained by the United States on the east side of the river at Northport from 1932 to 1937; and at Boundary in 1932, 1933, and in parts of 1934 and 1935; at Evans, south of Northport, from 1932 to 1934 and parts of 1935; and at Marble, in 1932 and 1933 and part of 1934; and the United States had at various times in 1939 and 1940 a portable recorder at Fowler Farm. The Dominion of Canada maintained recorders at Stroh Farm from 1932 to 1937 and from January to May 1938, and at a point opposite Northport on the west side of the River from 1937 to 1940—both of these recorders being in United States territory; and in Canadian territory, at Waneta, June to December, 1938, January to March, 1939, and June to December 1940, and at Columbia Gardens from May 1937 to December 1940.

Data compiled from the Northport recorder during the growing seasons, from April to September, 1938, 1939, and 1940, and from the Waneta recorder during the growing seasons while it was operated from June to September 1938 and 1940, and April to September, 1939, show the number of hours and minutes in each month during which fumes were present at the various concentrations of .11 to .25, .26 to .50, and above .50.

PART TWO.

The first question under Article III of the Convention is: "(1) Whether damage caused by the Trail Smelter in the State of Washington has occurred since the first day of January, 1932, and, if so, what indemnity should be paid therefor."

This question has been answered by the Tribunal in its previous decision, as to the period from January 1, 1932 to October 1, 1937, as set forth above. Concerning this question, three claims are now propounded by the United States.

I.

The Tribunal is requested to "reconsider its decision with respect to expenditures incurred by the United States during the period January 1, 1932, to June 30, 1936". It is claimed that "in this respect the United States is entitled to be indemnified in the sum of $89,655, with interest at the rate of five per centum per annum from the end of each fiscal year in which the several amounts were expended to the date of the Tribunal's final decision".

This claim was dealt with in the previous decision (Part Two, Clause (7)) and was disallowed.
The indemnity found by the Tribunal to be due for damage which had occurred since the first day of January, 1932, up to October 1, 1937, i.e., $78,000, was paid by the Dominion of Canada to the United States and received by the latter without reservations. (Record, Vol. 56, p. 6468.) The decision of the Tribunal in respect of damage up to October 1, 1937, was thus complied with in conformity with Article XII of the Convention. If it were not, in itself, final in this respect, the decision would have assumed a character of finality through this action of the parties.

But this finality was inherent in the decision. Article XI of the Convention says: "The Tribunal shall report to the Governments its final decisions ... as soon as it has reached its conclusions in respect to the questions..." and Article XII of the Convention, "The Governments undertake to take such action as may be necessary in order to ensure due performance of the obligations undertaken hereunder, in compliance with the decision of the Tribunal."

There can be no doubt that the Tribunal intended to give a final answer to Question I for the period up to October 1, 1937. This is made abundantly clear by the passage quoted above, in particular by the words: "This decision is not subject to alteration or modification by the Tribunal hereafter."

It might be argued that the words "as soon as it reached its conclusions in respect to the questions" show that the "final decisions" mentioned in Article XI of the Convention were not to be final until all the questions should have been answered.

In proceeding as it did the Tribunal did not act exclusively on its own interpretation of the Convention. It stated to the Governments its intention of granting damages for the period down to October 1, 1937, whilst ordering further investigations before establishing a permanent régime. It is with this understanding that both Governments, by an exchange of letters between the Minister of the United States at Ottawa and the Secretary of State of the Dominion of Canada (March 14, 1938, March 22, 1938), concurred in the extension of time requested.

This interpretation of Article XI of the Convention, moreover, is not in contradiction with the intention of the parties as expressed in the Convention. It was not foreseen at the time that further investigations might be needed, after the hearings had been ended, as proved to be the case. But the duty was imposed upon the Tribunal to reach a solution just to all parties concerned. This result could not have been achieved if the Tribunal had been forced to give a permanent decision as to a régime on the basis of data which it and both its scientific advisers considered inadequate and unsatisfactory. And, on the other hand, it is obvious that equity would not have been served if the Tribunal, having come to the conclusion that damage had occurred after January 1, 1937, had withheld its decision granting damages for more than two and one half years.

The Tribunal will now consider whether its decision concerning Question No. 1, up to October 1, 1937, constitutes res judicata.

As Dr. James Brown Scott (Hague Court Reports, p. XXI) expressed it: "... in the absence of an agreement of the contending countries excluding the law of nations, laying down specifically the law to be applied, international law is the law of an international tribunal". In deciding in conformity with international law an international tribunal may, and, in fact, frequently does apply national law; but an international tribunal will not depart from the rules of international law in favor of divergent rules of
not follow its fact findings, or where in any other respect the decision
does not comport with the record as made, or where the decision involves
a material error of law, the Commission not only has power, but is
under the duty, upon a proper showing, to re-open and correct a deci-
sion to accord with the facts and the applicable legal rules.

This statement may be entirely justified by circumstances special to the
Mixed Claims Commission, in particular by the practice followed \textit{ab initio}
by this Commission, apparently with the concurrence, until the Sabotage
cases reached their last stages, of the Umpire, the Commissioners and the
Agents, but in so far as it does not refer to the correction of possible errors
arising from a slip or accidental omission, it does not express the opinion
generally prevailing as to the position in international law, stated for instance
in the following passage of a recent decision: "... in order to justify revision
it is not enough that there has taken place an error on a point of law or in the
appreciation of a fact, or in both. It is only lack of knowledge on the part
of the judge and of one of the parties of a material and decisive fact which
may in law give rise to the revision of a judgment" (de Neuflize \textit{v.}
Disconto Gesellschaft, \textit{Recueil des Décisions des Tribunaux Arbitraux Mixtes}, t. VII,
1928, 629) \textsuperscript{1}.

A mere error in law is no sufficient ground for a petition tending to revision.
The formula "essential error" originated in a text voted by the Interna-
tional Law Institute in 1876. From its inception, its very authors were
divided as to its meaning. It is thought significant that the arbitral tribunal
in the Orinoco case avoided it; the Permanent Court in the Saint Naum case
alluded to it. The Government of the Kingdom of the Serbs, Croats and
Slovenes alleged essential error both in law and in fact (Series C, No. 5, II,
p. 57. Pleadings by Mr. Spalaikovitch), but what the Court had in mind in
the passage quoted above (see p. 36 of the present decision), was only a
possible error in fact. The paragraph where this passage appears begins
with the words: "This decision has also been criticized on the ground that
it was based on erroneous information or adopted without regard to certain
essential facts."

The Tribunal is of opinion that the proper criterion lies in a distinction
not between "essential" errors in law and other such errors, but between
"manifest" errors, such as that in the Schreck case or such as would be com-
mited by a tribunal that would overlook a relevant treaty or base its deci-
sion on an agreement admittedly terminated, and other errors in law. At
least, this is as far as it might be permissible to go on the strength of prece-
dents and practice. The error of interpretation of the Convention alleged
by the petitioner in revision is not such a "manifest" error. Further criti-
cisms need not be considered. The assumption that they are justified would
not suffice to upset the decision.

For these reasons, the Tribunal is of opinion that the petition must be
denied.

II (a).

The Tribunal is requested to say that damage has occurred in the State of
Washington since October 1, 1937, as a consequence of the emission of sul-
phur dioxide by the smelters of the Consolidated Mining and Smelting

\textsuperscript{1} This decision refers to the rules of procedure of the Franco-German Mixed
Arbitral Tribunals but these rules themselves are expressive of the opinion
generally prevailing as to the position in international law.
In the absence of authority established by settled precedents, the Tribunal is of opinion that, where an arbitral tribunal is requested to award the expenses of a Government incurred in preparing proof to support its claim, particularly a claim for damage to the national territory, the intent to enable the Tribunal to do so should appear, either from the express language of the instrument which sets up the arbitral tribunal or as a necessary implication from its provision. Neither such express language nor implication is present in this case.

It is to be noted from the above, that even if the Tribunal had the power to re-open the case as to the expenditures by the United States from January 1, 1932, to October 1, 1937, the Tribunal would have reached the same conclusion as to such expenditures and would have been obliged to affirm its decision made in the Report filed on April 16, 1938.

Since the Tribunal has, in its previous decision, answered Question No. 1 with respect to the period from the first day of January, 1932, to the first day of October, 1937, it now answers Question No. 1 with respect to the period from the first day of October, 1937, to the first day of October, 1940, as follows:

(1) No damage caused by the Trail Smelter in the State of Washington has occurred since the first day of October, 1937, and prior to the first day of October, 1940, and hence no indemnity shall be paid therefor.

PART THREE.

The second question under Article III of the Convention is as follows:

In the event of the answer to the first part of the preceding question being in the affirmative, whether the Trail Smelter should be required to refrain from causing damage in the State of Washington in the future and, if so, to what extent?

Damage has occurred since January 1, 1932, as fully set forth in the previous decision. To that extent, the first part of the preceding question has thus been answered in the affirmative.

As has been said above, the report of the International Joint Commission (1 (g)) contained a definition of the word "damage" excluding "occasional damage that may be caused by SO$_2$ fumes being carried across the international boundary in air pockets or by reason of unusual atmospheric conditions", as far, at least, as the duty of the Smelter to reduce the presence of that gas in the air was concerned.

The correspondence between the two Governments during the interval between that report and the conclusion of the Convention shows that the problem thus raised was what parties had primarily in mind in drafting Question No. 2. Whilst Canada wished for the adoption of the report, the United States stated that it could not acquiesce in the proposal to limit consideration of damage to damage as defined in the report (letter of the Minister of the United States of America at Ottawa to the Secretary of State for External Affairs of the Dominion of Canada, January 30, 1934). The view was expressed that "so long as fumigations occur in the State of Wash-

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Washington with such frequency, duration and intensity as to cause injury", the conditions afforded "grounds of complaint on the part of the United States, regardless of the remedial works . . . and regardless of the effect of those works" (same letter).

The first problem which arises is whether the question should be answered on the basis of the law followed in the United States or on the basis of international law. The Tribunal, however, finds that this problem need not be solved here as the law followed in the United States in dealing with the quasi-sovereign rights of the States of the Union, in the matter of air pollution, whilst more definite, is in conformity with the general rules of international law.

Particularly in reaching its conclusions as regards this question as well as the next, the Tribunal has given consideration to the desire of the high contracting parties "to reach a solution just to all parties concerned".

As Professor Eagleton puts in (Responsibility of States in International Law, 1928, p. 80): "A State owes at all times a duty to protect other States against injurious acts by individuals from within its jurisdiction." A great number of such general pronouncements by leading authorities concerning the duty of a State to respect other States and their territory have been presented to the Tribunal. These and many others have been carefully examined. International decisions, in various matters, from the Alabama case onward, and also earlier ones, are based on the same general principle, and, indeed, this principle, as such, has not been questioned by Canada. But the real difficulty often arises rather when it comes to determine what, pro subjecta materia, is deemed to constitute an injurious act.

A case concerning, as the present one does, territorial relations, decided by the Federal Court of Switzerland between the Cantons of Soleure and Argovia, may serve to illustrate the relativity of the rule. Soleure brought a suit against her sister State to enjoin use of a shooting establishment which endangered her territory. The court, in granting the injunction, said: "This right (sovereignty) excludes . . . not only the usurpation and exercise of sovereign rights (of another State) . . . but also an actual encroachment which might prejudice the natural use of the territory and the free movement of its inhabitants." As a result of the decision, Argovia made plans for the improvement of the existing installations. These, however, were considered as insufficient protection by Soleure. The Canton of Argovia then moved the Federal Court to decree that the shooting be again permitted after completion of the projected improvements. This motion was granted. "The demand of the Government of Soleure", said the court, "that all danger be absolutely abolished apparently goes too far." The court found that all risk whatever had not been eliminated, as the region was flat and absolutely safe shooting ranges were only found in mountain valleys; that there was a federal duty for the communes to provide facilities for military target practice and that "no more precautions may be demanded for shooting ranges near the boundaries of two Cantons than are required for shooting ranges in the interior of a Canton". (R. O. 26 I, p. 450, 451; R. O. 41, I, p. 137; see D. Schindler, "The Administration of Justice in the Swiss Federal Court in Intercantonal Disputes", American Journal of International Law, Vol. 15 (1921), pp. 172-174.)

No case of air pollution dealt with by an international tribunal has been brought to the attention of the Tribunal nor does the Tribunal know of any such case. The nearest analogy is that of water pollution. But, here also, no decision of an international tribunal has been cited or has been found.
There are, however, as regards both air pollution and water pollution, certain decisions of the Supreme Court of the United States which may legitimately be taken as a guide in this field of international law, for it is reasonable to follow by analogy, in international cases, precedents established by that court in dealing with controversies between States of the Union or with other controversies concerning the quasi-sovereign rights of such States, where no contrary rule prevails in international law and no reason for rejecting such precedents can be adduced from the limitations of sovereignty inherent in the Constitution of the United States.

In the suit of the State of Missouri *v.* the State of Illinois (200 U.S. 496, 521) concerning the pollution, within the boundaries of Illinois, of the Illinois River, an affluent of the Mississippi flowing into the latter where it forms the boundary between that State and Missouri, an injunction was refused. "Before this court ought to intervene", said the court, "the case should be of serious magnitude, clearly and fully proved, and the principle to be applied should be one which the court is prepared deliberately to maintain against all considerations on the other side. (See Kansas *v.* Colorado, 185 U.S. 125.)" The court found that the practice complained of was general along the shores of the Mississippi River at that time, that it was followed by Missouri itself and that thus a standard was set up by the defendant which the claimant was entitled to invoke.

As the claims of public health became more exacting and methods for removing impurities from the water were perfected, complaints ceased. It is significant that Missouri sided with Illinois when the other riparians of the Great Lakes' system sought to enjoin it to desist from diverting the waters of that system into that of the Illinois and Mississippi for the very purpose of disposing of the Chicago sewage.

In the more recent suit of the State of New York against the State of New Jersey (256 U.S. 296, 309), concerning the pollution of New York Bay, the injunction was also refused for lack of proof, some experts believing that the plans which were in dispute would result in the presence of "offensive odors and unsightly deposits", other equally reliable experts testifying that they were confidently of the opinion that the waters would be sufficiently purified. The court, referring to Missouri *v.* Illinois, said: "... the burden upon the State of New York of sustaining the allegations of its bill is much greater than that imposed upon a complainant in an ordinary suit between private parties. Before this court can be moved to exercise its extraordinary power under the Constitution to control the conduct of one State at the suit of another, the threatened invasion of rights must be of serious magnitude and it must be established by clear and convincing evidence."

What the Supreme Court says there of its power under the Constitution equally applies to the extraordinary power granted this Tribunal under the Convention. What is true between States of the Union is, at least, equally true concerning the relations between the United States and the Dominion of Canada.

In another recent case concerning water pollution (283 U.S. 473), the complainant was successful. The City of New York was enjoined, at the request of the State of New Jersey, to desist, within a reasonable time limit, from the practice of disposing of sewage by dumping it into the sea, a practice which was injurious to the coastal waters of New Jersey in the vicinity of her bathing resorts.

In the matter of air pollution itself, the leading decisions are those of the Supreme Court in the State of Georgia *v.* Tennessee Copper Company and
Ducktown Sulphur, Copper and Iron Company, Limited. Although dealing with a suit against private companies, the decisions were on questions cognate to those here at issue. Georgia stated that it had in vain sought relief from the State of Tennessee, on whose territory the smelters were located, and the court defined the nature of the suit by saying: "This is a suit by a State for an injury to it in its capacity of quasi-sovereign. In that capacity, the State has an interest independent of and behind the titles of its citizens, in all the earth and air within its domain."

On the question whether an injunction should be granted or not, the court said (206 U.S. 230):

It (the State) has the last word as to whether its mountains shall be stripped of their forests and its inhabitants shall breathe pure air.... It is not lightly to be presumed to give up quasi-sovereign rights for pay and.... if that be its choice, it may insist that an infraction of them shall be stopped. This court has not quite the same freedom to balance the harm that will be done by an injunction against that of which the plaintiff complains, that it would have in deciding between two subjects of a single political power. Without excluding the considerations that equity always takes into account.... it is a fair and reasonable demand on the part of a sovereign that the air over its territory should not be polluted on a great scale by sulphurous acid gas, that the forests on its mountains, be they better or worse, and whatever domestic destruction they may have suffered, should not be further destroyed or threatened by the act of persons beyond its control, that the crops and orchards on its hills should not be endangered from the same source.... Whether Georgia, by insisting upon this claim, is doing more harm than good to her own citizens, is for her to determine. The possible disaster to those outside the State must be accepted as a consequence of her standing upon her extreme rights.

Later on, however, when the court actually framed an injunction, in the case of the Ducktown Company (237 U.S. 474, 477) (an agreement on the basis of an annual compensation was reached with the most important of the two smelters, the Tennessee Copper Company), they did not go beyond a decree "adequate to diminish materially the present probability of damage to its (Georgia's) citizens".

Great progress in the control of fumes has been made by science in the last few years and this progress should be taken into account.

The Tribunal, therefore, finds that the above decisions, taken as a whole, constitute an adequate basis for its conclusions, namely, that, under the principles of international law, as well as of the law of the United States, no State has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or persons therein, when the case is of serious consequence and the injury is established by clear and convincing evidence.

The decisions of the Supreme Court of the United States which are the basis of these conclusions are decisions in equity and a solution inspired by them, together with the régime hereinafter prescribed, will, in the opinion of the Tribunal, be "just to all parties concerned", as long, at least, as the present conditions in the Columbia River Valley continue to prevail.

Considering the circumstances of the case, the Tribunal holds that the Dominion of Canada is responsible in international law for the conduct of the Trail Smelter. Apart from the undertakings in the Convention, it is,
therefore, the duty of the Government of the Dominion of Canada to see to it that this conduct should be in conformity with the obligation of the Dominion under international law as herein determined.

The Tribunal, therefore, answers Question No. 2 as follows: (2) So long as the present conditions in the Columbia River Valley prevail, the Trail Smelter shall be required to refrain from causing any damage through fumes in the State of Washington; the damage herein referred to and its extent being such as would be recoverable under the decisions of the courts of the United States in suits between private individuals. The indemnity for such damage should be fixed in such manner as the Governments, acting under Article XI of the Convention, should agree upon.

PART FOUR.

The third question under Article III of the Convention is as follows: "In the light of the answer to the preceding question, what measures or régime, if any, should be adopted and maintained by the Trail Smelter?"

Answering this question in the light of the preceding one, since the Tribunal has, in its previous decision, found that damage caused by the Trail Smelter has occurred in the State of Washington since January 1, 1932, and since the Tribunal is of opinion that damage may occur in the future unless the operations of the Smelter shall be subject to some control, in order to avoid damage occurring, the Tribunal now decides that a régime or measure of control shall be applied to the operations of the Smelter and shall remain in full force unless and until modified in accordance with the provisions hereinafter set forth in Section 3, Paragraph VI of the present part of this decision.

SECTION 1.

The Tribunal in its previous decision, deferred the establishment of a permanent régime until more adequate knowledge had been obtained concerning the influence of the various factors involved in fumigations resulting from the operations of the Trail Smelter.

For the purpose of administering an experimental period, to continue to a date not later than October 1, 1940, during which studies could be made of the meteorological conditions in the Columbia River Valley, and of the extension and improvements of the methods for controlling smelter operations in closer relation to such meteorological conditions, the Tribunal, as said before, appointed two Technical Consultants, who directed the observations, experiments and operations through the remainder of the crop-growing season of 1938, the crop-growing seasons of 1939 and 1940 and the winter seasons of 1938-1939 and 1939-1940. The Tribunal appointed as Technical Consultants the two scientists who had been designated by the Governments to assist the Tribunal, Dr. R. S. Dean and Professor R. E. Swain.

The previous decision directed that during the trial period, a consulting meteorologist, to be appointed with the approval of the Technical Consultants, should be employed by the Trail Smelter. On May 4, 1938, Dr. J. Patterson was thus appointed. On May 1, 1939, Dr. Patterson resigned to take up meteorological service in the Canadian Air Force, and Dr. E. W. Hewson was given leave from the Dominion Meteorological Service and appointed in his stead.
The previous decision further directed the installation, operation and maintenance of such observation stations, of such equipment at the stacks and of such sulphur dioxide recorders (the permanent recorders not to exceed three in number) as the Technical Consultants would deem necessary. The Technical Consultants were empowered to require regular reports from the Trail Smelter as to the methods of operation of its plant and the latter was to conduct its smelting operations in conformity with the directions of the Technical Consultants and of the Tribunal; these instructions could and, in fact, were modified from time to time on the result of the data obtained.

As further provided in the previous decision, the Technical Consultants regularly reported to the Tribunal which, as said before, met in 1939 to consult verbally with them about the temporary régime.

The previous decision finally prescribed that the Dominion of Canada should undertake to provide for the payment of the expenses resulting from this temporary régime.

On May 4, 1938, the Tribunal authorized and directed the employment of Dr. John P. Nielsen, an American citizen, engaged for three years in postgraduate work at Stanford University, in chemistry and plant physiology, as an assistant to the Technical Consultants; Dr. Nielsen continued in this capacity until October 1, 1938.

Through the authority vested in it by the Tribunal, this technical staff was enabled to study the influence of meteorological conditions on dispersion of the sulphurous gases emitted from the stacks of the smelter. This involved the establishment, operation, and maintenance of standard and newly designed meteorological instruments and of sulphur-dioxide recorders at carefully chosen localities in the United States and the Dominion of Canada, and the design and construction of portable instruments of various types for the observation of conditions at numerous surface locations in the Columbia River Valley and in the atmosphere over the valley. Observations on height, velocity, temperature, sulphur dioxide content, and other characteristics of the gas-carrying air currents, were made with the aid of captive balloons, pilot balloons and airplane flights. These observations were begun in May, 1938, and after information as to the inter-relation between meteorological conditions and sulphur-dioxide distribution had been obtained, the observations were continued throughout several experimental régimes of smelter operation during 1939 and 1940.

Periodic examination of crops and timber in the area claimed to be affected were made at suitable times by members of the technical staff.

The full details of the projects undertaken, the methods of study used, and the results obtained may be found in the final report entitled *Meteorological Investigations near Trail, B.C., 1938-1940*, by Reginald S. Dean and Robert E. Swain (an elaborate document of 374 pages accompanied by numerous scientific charts, graphs and photographs, copies of which have been filed with the two Governments and have been made a part of the record by the Tribunal).

The Tribunal expresses the hope that the two Governments may see fit to make this valuable report available to scientists and smelter operators generally, either by printing or other form of reproduction.
The investigations during the experimental period make it clear that in the carrying out of a régime, automatic recorders should be located and maintained for the purpose of aiding in control of the emission of fumes at the Smelter and to provide data for observation of the effect of the controls on fumigations.

The investigations carried out by the Technical Consultants have confirmed the idea that the dissipation of the sulphur dioxide gas emitted from the Smelter takes place by eddy-current diffusion. The form of the attenuation curve for sulphur dioxide with distance from the Smelter is, therefore, determined by this mechanism of gas dispersion.

Analysis of the recorder data collected since May, 1938, confirms the conclusion of the Tribunal stated in its previous decision to the effect that "the concentration of sulphur dioxide falls off very rapidly from Trail to a point about 16 miles downstream from the Smelter, or 6 miles from the boundary line, measured by the general course of the river; and that at distances beyond this point, the concentration of sulphur-dioxide is lower and falls off more gradually and less rapidly". The position of the knee in this attenuation curve is somewhat affected by wind velocity and direction, and by other factors.

From an examination of the recorded data, it appears that the Columbia Gardens recorder located 6 miles below the Smelter, is above the knee of the attenuation curve. The Waneta recorder, 10 miles below the Smelter, is still in the region of very rapid decrease of sulphur dioxide while the Northport recorder, 19 miles below the Smelter, is well below the knee of the curve. There is very little variation in the average ratio of concentrations between the various recorders. For example, the average ratio for the years 1932 to 1935, between Columbia Gardens and Northport, was 1 to .31, while the average ratio for the experimental period from May, 1938, to November, 1940, was 1 to .39. The individual variations from this ratio are relatively small. The ratio between Columbia Gardens and Waneta for the period 1932 to 1933 was .6 and that for the period May 1938, to November 1940, was .75. The individual variations of the ratio between Columbia Gardens and Waneta are, however, much greater than those between Columbia Gardens and Northport. It is accordingly found that the Columbia Gardens recorder and the Northport recorder give as complete a picture of the attenuation of sulphur dioxide with distance as can be obtained with any reasonable number of recorders.

It may be fairly assumed that the sulphur dioxide concentration at Columbia Gardens will fall off quite rapidly with distance away from the Smelter, and that a concentration very close to that recorded at Northport will be reached several miles above Northport. Concentrations recorded at intermediate points are functions of a number of variables other than distance from the Smelter. It may be generally assumed that the concentration in the neighborhood of the border will be from .6 to .75 of that recorded at Columbia Gardens. Individual variations, however, are likely to be somewhat greater than this, and in unusual instances concentrations near the border may be substantially equal to those at Columbia Gardens.

Although as a result of the investigations carried out by the Technical Consultants, the conclusion might be warranted that the Waneta recorder could be discontinued, it has, nevertheless, been decided to have it main-
tained for a limited period of further investigations, particularly as it was removed from its present location during one winter season of the trial period. As an alternative to Waneta, a location suggested by the United States, Gunderson Farm (on the west bank of the river in Section 12, T. 40, R. 40), was considered. The difficulties inherent in servicing a recorder in that location, particularly in winter time, would not be compensated. It was thought, by any appreciable advantages. It was further considered that Waneta—a location practically identical to that of Boundary which the United States’ scientists had selected in the past—jutting out as it does almost into the middle of the Columbia Valley where it swerves to the west, is one of the best sites that could be chosen for a recorder in that vicinity. The Tribunal, having gone into the matter with great care, is convinced that this choice is not adversely affected by the vicinity of the narrow gorge of the Pend-d’Oreille River.

(b)

The year is divided into two parts, which correspond approximately with the summer and winter seasons: viz., the growing season which extends from April 1 through the summer to September 30, and the non-growing season which extends from October 1 through the winter to April 1. Atmospheric conditions in the Columbia River Valley during the summer vary widely from those in the winter. During the summer, or growing season, the air is generally in active movement with little tendency toward extended periods of calm, and smoke from the Smelter is rapidly dispersed by the frequent changes in wind direction and velocity and the higher degree of atmospheric turbulence. During the winter, or non-growing season, calm conditions may prevail for several days and smoke from the Smelter may be dispersed only very slowly.

In general, a similar variation in atmospheric stability occurs during the day. The air through the early morning hours until about nine o’clock is not subject to very rapid movement, but from around ten o’clock in the morning until late at night there is usually more wind and turbulence, with the exception of a quiet spell which often occurs during the late afternoon. During the growing season, there is furthermore a marked diurnal variation of wind changes whose maximum frequency occurs at noon for the general direction from north to south and at seven o’clock in the evening for the general direction from south to north. This diurnal variation of wind changes does not occur so frequently during the non-growing season. During the growing season, the descent of sulphur dioxide to the earth’s surface is more likely to occur at some hours than at others. At about nine to ten o’clock in the morning, there is usually a very pronounced maximum of fumigations, and this morning fumigation occurs with such regularity that it has been the practice of the Smoke Control Office at the Smelter for some time to cut down the emission of sulphur to the atmosphere during the early morning hours and to keep it down until from eight to eleven o’clock in the morning. The amount and duration of the cut are determined after an analysis of the wind velocity and direction, and of the conditions of turbulence or diffusion of the smoke. This is a fundamental feature of the program of smoke control, and the main reason for its success is that it prevents accumulations of sulphur dioxide which tend to descend from higher elevations when the early morning sun disturbs the thermal balance by heating the earth’s surface. This early morning diurnal fumigation reaches
all recorders in the valley almost simultaneously, the intensity being usually highest near the Smelter. The concentration of sulphur dioxide during this type of fumigation rises as a rule very rapidly to a maximum in a few minutes and then drops off exponentially, only traces often remaining after two or three hours. A similar diurnal fumigation, usually of shorter duration, is occasionally observed in the early evening due to a disturbance of the thermal balance as the sun sets.

Sulphur dioxide sampling by airplane has indicated that in calm weather and especially in the early morning hours, the effluent gases hold to a fairly well-defined pattern in the early stages of their dispersion. The gases rise about 400 feet above the top of the two high stacks, then level out and spread horizontally along the main axis of the prevailing wind movement. During the relatively quiet conditions frequently found in the early morning, an atmospheric stratum carrying fairly high concentrations of sulphur dioxide and spreading over a large area may be formed.

With the rising of the sun, the radiational heating of the atmosphere near the surface may disturb the thermal balance, resulting in the descent of the sulphur dioxide which had accumulated in the upper layers at approximately 2,400 feet elevation above mean sea level, and extending either up-stream or down-stream from the Smelter, depending on wind direction. This readily explains the simultaneous appearance of sulphur dioxide at various distances from the Smelter.

During the non-growing season, the non-diurnal type of fumigation predominates. In this type, the sulphur dioxide leaving the stacks is carried along the valley in a general drift of air, diffusing more or less uniformly as it advances. From two to eight hours are usually required for the smoke to get from Trail to Northport when the drift is down river. Such fumigations are not recorded simultaneously on the various recorders but the gas is first noted nearest the Smelter and then in succession at the other recorders. The concentration at a given recorder often shows very little variation as long as it lasts, which might be for several days depending entirely upon wind velocity and direction.

It is an interesting fact that the agricultural growing season and the non-growing season coincide almost exactly with the periods in which diurnal and non-diurnal fumigations respectively, are dominant. The transition from diurnal to non-diurnal fumigations and vice versa occurs in September and April. Diurnal fumigations sometimes occur during the non-growing season but with much less frequency and regularity than during the growing season, and at a later hour because of the later sunrise in winter. Similarly, the non-diurnal type sometimes occurs during the growing season. Its manifestations are then the same as during the winter, the chief difference being that it rarely lasts as long.

Sulphur dioxide recorders can be used to assist in smoke control during both the growing and non-growing season. They are more useful in the latter season, however, because in a non-diurnal fumigation, the gas usually appears at Columbia Gardens some time before it reaches Northport, and high concentrations recorded at the former location serve as warnings that more sulphur dioxide is being emitted than can adequately be dispersed under the prevailing atmospheric conditions. This information may lead to a decrease in the amount of sulphur dioxide emitted from the Smelter in time to avoid serious consequences. With the diurnal type of fumigations, on the other hand, high concentrations of sulphur dioxide may descend from the upper atmosphere to the surface with little or no warning, and the
only adequate protection against this type of fumigation is to prevent accumulations of large amounts of sulphur dioxide, either up or down stream, at or just before the periods when diurnal fumigations may be expected.

(c)

Observations over a period of years have indicated that there is little likelihood of gas being carried across the international boundary if the wind in the gas-carrying levels, approximately 2,400 feet above mean sea level, is in a direction not included in the 135° angle opening to the westward starting with north, and has a velocity sufficient to insure that no serious accumulation of smoke occurs. A recording cup anemometer and an anemovane suspended 300 feet above the surface, 1,900 feet above mean sea level, from a cable between the tops of the zinc stack and a neighboring lower stack, indicate the velocity and direction of the wind reliably except when the velocity or direction of the wind at this level differs from that in the gas-carrying level 500 feet or more higher. An attempt has been made to use the geostrophic wind forecasts made by the Weather Bureau at Vancouver for predicting the velocity and direction of the wind at these higher levels, but the results, although promising, have not yet been sufficiently certain to warrant the use of geostrophic winds as a factor in smoke control. (For further details, see Report of the Technical Consultants.)

(d)

A very significant factor in determining how much sulphur dioxide can safely be emitted by the Smelter is the rate of eddy current diffusion. When the rate of diffusion is low, smoke may accumulate in parts of the valley. Such accumulations frequently occur up-stream from the Smelter when there is a light up-river breeze.

The main factors governing the rate of diffusion of sulphur dioxide are the turbulence and lapse rate of the air. Turbulence is used instead of the more homely term gustiness to express the action of eddy currents in the air stream. Turbulence, therefore, is expressed in terms of changes in wind velocity over definite intervals of time, and may be measured by observations on standard anemometers, as has been done during the early stages of these meteorological studies. It has been found, however, that different observers using this method of measurement were not in agreement when the changes in velocity occurred rapidly and were of great intensity. It was furthermore found that the sensitivity of standard anemometers was not sufficient to give the desired precision. A number of modifications have been made which have led finally to the design and construction of an instrument called the Bridled Cup Indicator, which is more sensitive than any of the other instruments used, and is also free from personal error in the reading of the instrumental record.

(e)

There are several limitations to the application of the turbulence criterion. On a number of occasions, marked fumigations have occurred when the instrument showed that the turbulence was good or excellent. On every occasion of that sort which has been studied, pilot balloon observations revealed that there was a strong down-river wind from the surface of the
### GROWING SEASON

<table>
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<td>Bad</td>
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<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Wind</td>
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<tr>
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### NON-GROWING SEASON

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<td>3 hrs. before sunset to sunset .....</td>
<td>2</td>
<td>7</td>
<td>5</td>
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<td>7</td>
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<tr>
<td>Sunset to midnight . .</td>
<td>3</td>
<td>9</td>
<td>6</td>
<td>11</td>
<td>9</td>
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<td>11</td>
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**General Restrictions and Provisions.**

(a) If the Columbia Gardens recorder indicates 0.3 part per million or more of sulphur dioxide for two consecutive twenty minute periods during the growing season, and the wind direction is not favorable, emission shall be reduced by four tons of sulphur per hour or shut down completely when the turbulence is bad, until the recorder shows 0.2 part per million or less of sulphur dioxide for three consecutive twenty minute periods.

If the Columbia Gardens recorder indicates 0.5 part per million or more of sulphur dioxide for three consecutive twenty minute periods during the non-growing season and the wind direction is not favorable, emission shall be reduced by four tons of sulphur per hour or shut down completely when the turbulence is bad, until the recorder shows 0.2 part per million or less of sulphur dioxide for three consecutive twenty minute periods.
(b) In case of rain or snow, the emission of sulphur shall be reduced by two (2) tons per hour. This regulation shall be put into effect immediately when precipitation can be observed from the Smelter and shall be continued in effect for twenty (20) minutes after such precipitation has ceased.

(c) If the slag retreatment furnace is not in operation the emission of sulphur shall be reduced by two (2) tons per hour.

(d) If the instrumental reading shows turbulence excellent, good or fair, but visual observations made by trained observers clearly indicate that there is poor diffusion, the emission of sulphur shall be reduced to the figures given in column (1) if wind is not favorable, or column (2) if wind is favorable.

(e) When more than one of the restricting conditions provided for in (a), (b), (c), and (d) occur simultaneously, the highest reduction shall apply.

(f) If, during the non-growing season, the instrumental reading shows turbulence fair and wind not favorable but visual observations by trained observers clearly indicate that there is excellent diffusion, the maximum permissible emission of sulphur may be increased to the figures in column (5). The general restrictions under (a), (b), (c) and (e), however, shall be applicable.

Whenever the Smelter shall avail itself of the foregoing provisions, the circumstances shall be fully recorded and copy of such record shall be sent to the two Governments within one month.

(g) Nothing shall relieve the Smelter from the duty of reducing the maximum sulphur emission below the amount permissible according to the tables and the preceding general restrictions and provisions, as the circumstances may require for the prudent operation of the plant.

V. Definition of Terms and Conditions

(a) Wind Direction and Velocity—The following directions of wind shall be considered favorable provided they show a velocity of five miles per hour or more and have persisted for thirty minutes at the point of observation, namely north, east, south, southwest, and intermediate directions, that is any direction not included in the one hundred and thirty-five (135) degree angle opening to the westward starting with north.

All winds not included in the above definition shall be considered not favorable.

(b) Turbulence—The following definitions are made of bad, fair, good, and excellent turbulence. The figures given are in terms of the Bridled Cup Turbulence Indicator for a period of one half hour:

<table>
<thead>
<tr>
<th>Level</th>
<th>Turbulence</th>
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<tr>
<td>Bad</td>
<td>0-74</td>
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<tr>
<td>Fair</td>
<td>75-149</td>
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<tr>
<td>Good</td>
<td>150-349</td>
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<tr>
<td>Excellent</td>
<td>350 and above</td>
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</table>

If at any time another instrument should be found to be better adapted to the measurement of turbulence, and should be accepted for such measure-
VI. Amendment or Suspension of the Régime.

If at any time after December 31, 1942, either Government shall request an amendment or suspension of the régime herein prescribed and the other Government shall decline to agree to such request, there shall be appointed by each Government, within one month after the making or receipt respectively of such request, a scientist of repute; and the two scientists so appointed shall constitute a Commission for the purpose of considering and acting upon such request. If the Commission within three months after appointment fail to agree upon a decision, they shall appoint jointly a third scientist who shall be Chairman of the Commission; and thereupon the opinion of the majority, or in the absence of any majority opinion, the opinion of the Chairman shall be decisive; the opinion shall be rendered within one month after the choice of the Chairman. If the two scientists shall fail to agree upon a third scientist within the prescribed time, upon the request of either, he shall be appointed within one month from such failure by the President of the American Chemical Society, a scientific body having a membership both in the United States, Canada, Great Britain and other countries.

Any of the periods of time herein prescribed may be extended by agreement between the two Governments.

The Commission of two, or three scientists as the case may be, may take such action in compliance with or in denial of the request above referred to, either in whole or in part, as it deems appropriate for the avoidance or prevention of damage occurring in the State of Washington. The decision of the Commission shall be final, and the Governments shall take such action as may be necessary to ensure due conformity with the decision, in accordance with the provisions of Article XII of the Convention.

The compensation of the scientists appointed and their reasonable expenditures shall be paid by the Government which shall have requested a decision; if both Governments shall have made a request for decision, such expenses shall be shared equally by both Governments; provided, however, that if the Commission in response to the request of the United States shall find that notwithstanding compliance with the régime in force damage has occurred through fumes in the State of Washington, then the above expenses shall be paid by the Dominion of Canada.

SECTION 4.

While the Tribunal refrains from making the following suggestion a part of the régime prescribed, it is strongly of the opinion that it would be to the clear advantage of the Dominion of Canada, if during the interval between the date of filing of this Final Report and December 31, 1942, the Dominion of Canada would continue, at its own expense, the maintenance of experimental and observational work by two scientists similar to that which was established by the Tribunal under its previous decision, and has been in operation during the trial period since 1938. It seems probable that a continuance of investigations until at least December 31, 1942, would provide additional valuable data both for the purpose of testing the effective operation of the régime now prescribed and for the purpose of obtaining information as to the possibility or necessity of improvements in it.
for damage; and further it is understood that such payment is hereby directed by the Tribunal only as a compensation to be paid on account of the answers of the Tribunal to Question No. 2 and Question No. 3 (as provided for in Question No. 4) and not as any part of indemnity for the damage to be ascertained and to be determined upon by the two Governments under Article XI of the Convention.

PART SIX.

Since further investigations in the future may be possible under the provisions of Part Four and of Part Five of this decision, the Tribunal finds it necessary to include in its report, the following provision:

Investigators appointed by or on behalf of either Government, whether jointly or severally, and the members of the Commission provided for in Paragraph VI of Section 3 of Part Four of this decision, shall be permitted at all reasonable times to inspect the operations of the Smelter and to enter upon and inspect any of the properties in the State of Washington which may be claimed to be affected by fumes. This provision shall also apply to any localities where instruments are operated under the present régime or under any amended régime. Wherever under the present régime or any amended régime, instruments have to be maintained and operated by the Smelter on the territory of the United States, the Government of the United States shall undertake to secure for the Government of the Dominion of Canada the facilities reasonably required to that effect.

The Tribunal expresses the strong hope that any investigations which the Governments may undertake in the future, in connection with the matters dealt with in this decision, shall be conducted jointly.

(Signed) JAN HOSTIE.
(Signed) CHARLES WARREN.
(Signed) R. A. E. GREENSHIELDS.

ANNEX.

I. Letter from the Members of the Tribunal to the Secretary of State of the United States and Secretary of State for External Affairs of Canada, May 6, 1941.

TRAIL SMELTER ARBITRAL TRIBUNAL.
UNITED STATES AND CANADA.

710 MILLS BUILDING,
WASHINGTON, D.C.

SIR:

May 6, 1941.

The Trail Smelter Arbitral Tribunal has received from its scientific advisers in that case, a letter dated April 28, 1941, copy of which is here-with enclosed. The members of the Tribunal think that it is their duty in transmitting this letter to both Governments, to declare that the statement contained therein is the correct interpretation of Clause IV, Section 3 of Part Four of the Decision reported on March 11, 1941.

Respectfully yours,

JAN HOSTIE.
CHARLES WARREN.
R. A. E. GREENSHIELDS.