PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
RAJ, VINU

HAYNES AND BOONE, LLP 2323 VICTORY AVENUE,
SUITE 700 DALLAS TX 75219 USA

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing *(day/month/year)* **27 February 2018 (27.02.2018)**

Applicant's or agent's file reference
75231904WO01

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2017/050125	**05 September 2017 (05.09.2017)**	

International Patent Classification (IPC) or both national classification and IPC
G01T 7/00(2006.01)i, G01T 1/167(2006.01)i

Applicant
HALLIBURTON ENERGY SERVICES, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
International Application Division Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea Facsimile No. +82-42-481-8578	26 February 2018 (26.02.2018)	LEE, Chang Ho Telephone No. +82-42-481-8288

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2017/050125

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of :

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:
      ☐ in the form of an Annex C/ST.25 text file.
      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

   c. ☐ furnished subsequent to the international filing date for the purposes of international search only:
      ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).
      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2017/050125

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: WO 2017-069865 A1 (HALLIBURTON ENERGY SERVICES, INC.) 27 April 2017
D2: US 2015-0177198 A1 (SCHLUMBERGER TECHNOLOGY CORPORATION) 25 June 2015

1. Novelty and Inventive Step

1.1 Independent Claim 1

D1, which is considered to be the closest prior art to the subject matter of claim 1, discloses a method of calibrating gamma ray logging tools using simulated data, the method comprising: simulating gamma ray emissions of a formation and obtaining a counting rate response of a first logging tool; comparing the obtained counting rate with measured counting rates; and determining a second API unit sensitivity factor calculated using a third counting rate of a second logging tool (see column 1, lines 1-2, column 3, line 25-column 4, line 2, column 11, lines 11-15, column 15, lines 18-23, column 16, lines 11-22).

Claim 1 differs from D1 in that a method comprises when a simulated counting rate is determined to match a measured counting rate, determining a tally multiplier and a corresponding material specification for a model of a first blanket calibrator (hereinafter 'feature 1-1'); simulating a counting rate for a second gamma ray tool based on the tally multiplier and the material specification determined for the model of the first blanket calibrator (hereinafter 'feature 1-2'); and calibrating a second gamma ray tool according to a nominal blanket activity calculated from a sensitivity factor of the second gamma ray tool (hereinafter 'feature 1-3'). However, feature 1-1 would be easily conceived from the combination of D1 considering calculating a tally multiplier (see column 16, lines 3-10) and D2 considering that an acoustic calibration apparatus may include a first material that has first known acoustic properties (e.g., simulating a solid) and a second material that has second known acoustic properties (e.g.,

Continued on Supplemental Box

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/US2017/050125

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claim 6 contains a minor typo of "the second gammy ray tool" which should read "the second gamma ray tool" (PCT Article 6).

The phrase "the radioactive material" in claims 10 and 19 has not been defined before the expression. Therefore, claims 10 and 19 do not meet the requirements of PCT Article 6.

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Box No. V

simulating a liquid or gas) (see paragraph [0008]). Features 1-2 and 1-3 would be easily conceived from D1 considering calculating the third counting rate of the second logging tool based on the tally multiplier; and calibrating the gamma ray logging tools using the simulated data of one or more activity zones (see column 1, lines 1-2, column 11, lines 11-15, column 16, lines 11-22), and D1 and D2 are concerned with mutually related technical fields.

Accordingly, claim 1 would have been obvious over D1 in view of D2. Therefore, claim 1 lacks an inventive step under PCT Article 33(3).

1.2 Dependent Claims 2-10

1.2.1 Concerning Claim 2

The additional feature of claim 2, characterized in that the first gamma ray tool is a previously calibrated gamma ray tool having a known design or configuration and the second gamma ray tool is an uncalibrated gamma ray tool having a new design or configuration, would be easily conceived from D1 considering a reference logging condition of the first logging tool; and a second uncased proxy formation model simulated for the second oversized logging tool (see column 10, lines 13-31). Accordingly, claim 2 would have been obvious over D1 in view of D2. Therefore, claim 2 lacks an inventive step under PCT Article 33(3).

1.2.2 Concerning Claim 3

The additional feature of claim 3 is identical to the feature of D1 that the API unit sensitivity factor for the simulated second logging tool is calculated (see column 3, line 25-column 4, line 2). Accordingly, claim 3 would have been obvious over D1 in view of D2. Therefore, claim 3 lacks an inventive step under PCT Article 33(3).

1.2.3 Concerning Claim 4

The additional feature of claim 4, characterized in that the first blanket calibrator is a reference blanket calibrator, would be easily conceived from D1 considering the reference logging condition of the first logging tool (see column 16, lines 11-22). Accordingly, claim 4 would have been obvious over D1 in view of D2. Therefore, claim 4 lacks an inventive step under PCT Article 33(3).

Continued on The Next Page

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Previous Page

1.2.4 Concerning Claim 5

The additional feature of claim 5 is identical to the feature of D1 that simulating the gamma ray emissions comprises simulating a low activity zone of the formation and calculating a first counting rate for the low activity zone, and simulating a high activity zone of the formation and calculating a second counting rate for the high activity zone; and the API unit sensitivity factor is calculated based upon the first and second counting rates (see column 15, lines 26-31). Accordingly, claim 5 would have been obvious over D1 in view of D2. Therefore, claim 5 lacks an inventive step under PCT Article 33(3).

1.2.5 Concerning Claim 6

The additional features of claim 6 are characterized in that determining the sensitivity factor comprises: calculating a tally multiplier for a model of a second blanket calibrator, based on the tally multiplier of the first blanket calibrator (hereinafter 'feature 6-1'); determining a thorium concentration corresponding to the tally multiplier of the model of the second blanket calibrator (hereinafter 'feature 6-2'); determining a material specification for the model of the second blanket calibrator, based on the thorium concentration (hereinafter 'feature 6-3'); simulating a counting rate for the second gammy ray tool, based on the tally multiplier and the material specification determined for the model of the second blanket calibrator (hereinafter 'feature 6-4'); and calculating the sensitivity factor for the second gamma ray tool, based on the counting rate simulated for the respective first and second blankets (hereinafter 'feature 6-5'). Features 6-1 and 6-4 would be easily conceived from D1 considering calculating a tally multiplier; and calculating the third counting rate of the second logging tool based on the tally multiplier (see column 11, lines 11-15, column 16, lines 3-22), features 6-2 and 6-5 are identical to the features of D1 of obtaining a set of elemental concentrations that were included in the average elemental concentrations for the low and high activity zones; and calculating the API unit sensitivity factor, based on the counting rates determined (see column 9, lines 8-14, column 11, lines 21-27), and feature 6-3 would be easily conceived from D2 considering that the acoustic calibration apparatus may include the first material that has first known acoustic properties (e.g., simulating a solid) and the second material that has second known acoustic properties (e.g., simulating a liquid or gas) (see paragraph [0008]). Accordingly, claim 6 would have been obvious over D1 in view of D2. Therefore, claim 6 lacks an inventive step under

Continued on The Next Page

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Previous Page

PCT Article 33(3).

1.2.6 Concerning Claims 7-8

The additional features of claims 7-8 are identical to the features of D2 that the acoustic calibration apparatus (46) and a coupling device (47) may have a similar construction of cloth and belting materials to those of surface-based nuclear calibration blankets used to calibrate nuclear downhole tools (see paragraph [0035] and figures 1-2, 4). Accordingly, claims 7-8 would have been obvious over D1 in view of D2. Therefore, claims 7-8 lack an inventive step under PCT Article 33(3).

1.2.7 Concerning Claim 9

The additional feature of claim 9 is identical to the feature of D1 of simulating gamma ray emissions of a formation using Monte Carlo modeling (see column 3, line 25-column 4, line 2). Accordingly, claim 9 would have been obvious over D1 in view of D2. Therefore, claim 9 lacks an inventive step under PCT Article 33(3).

1.2.8 Concerning Claim 10

The additional feature of claim 10 is identical to the feature of D1 that version 4CP2 of MCNP may be applied for the calculations (see column 11, lines 6-10). Accordingly, claim 10 would have been obvious over D1 in view of D2. Therefore, claim 10 lacks an inventive step under PCT Article 33(3).

1.3 Independent Claim 11

D1, which is considered to be the closest prior art to the subject matter of claim 11, discloses a system for calibrating gamma ray logging tools using simulated data, the system comprising: processing circuitry including at least one processor and a computer-readable storage medium having instructions stored therein, which cause the processor to perform functions including functions to: simulate gamma ray emissions of a formation and obtain a counting rate response of a first logging tool; compare the obtained counting rate with measured counting rates; and determine a second API unit sensitivity factor calculated using a

Continued on The Next Page

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Previous Page

third counting rate of a second logging tool (see column 1, lines 1-2, column 3, line 25-column 4, line 2, column 11, lines 11-15, column 14, lines 7-23, column 15, lines 18-23, column 16, lines 11-22).

Claim 11 differs from D1 in that a system comprises functions to: when a simulated counting rate is determined to match a measured counting rate, determine a tally multiplier and a corresponding material specification for a model of a first blanket calibrator (hereinafter 'feature 11-1'); simulate a counting rate for a second gamma ray tool based on the tally multiplier and the material specification determined for the model of the first blanket calibrator (hereinafter 'feature 11-2'); and calibrate the second gamma ray tool according to a nominal blanket activity calculated from a sensitivity factor of the second gamma ray tool (hereinafter 'feature 11-3'). However, feature 11-1 would be easily conceived from the combination of D1 considering calculating a tally multiplier (see column 16, lines 3-10) and D2 considering that an acoustic calibration apparatus may include a first material that has first known acoustic properties (e.g., simulating a solid) and a second material that has second known acoustic properties (e.g., simulating a liquid or gas) (see paragraph [0008]). Features 11-2 and 11-3 would be easily conceived from D1 considering calculating the third counting rate of the second logging tool based on the tally multiplier; and calibrating the gamma ray logging tools using the simulated data of one or more activity zones (see column 1, lines 1-2, column 11, lines 11-15, column 16, lines 11-22), and D1 and D2 are concerned with mutually related technical fields.

Accordingly, claim 11 would have been obvious over D1 in view of D2. Therefore, claim 11 lacks an inventive step under PCT Article 33(3).

1.4 Dependent Claims 12-19

1.4.1 Concerning Claim 12

The additional feature of claim 12, characterized in that the first blanket calibrator is a reference blanket calibrator, the first gamma ray tool is a previously calibrated gamma ray tool having a known design or configuration, and the second gamma ray tool is an uncalibrated gamma ray tool having a new design or configuration, would be easily conceived from D1 considering a reference logging condition of the first logging tool; and a second uncased proxy formation model simulated for the second oversized logging tool (see column 10, lines 13-31, column 16, lines 11-22). Accordingly, claim 12 would have been obvious over D1 in view of

Continued on The Next Page

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Previous Page

D2. Therefore, claim 12 lacks an inventive step under PCT Article 33(3).

1.4.2 Concerning Claim 13

The additional feature of claim 13 is identical to the feature of D1 that the API unit sensitivity factor for the simulated the second logging tool is calculated (see column 3, line 25-column 4, line 2). Accordingly, claim 13 would have been obvious over D1 in view of D2. Therefore, claim 13 lacks an inventive step under PCT Article 33(3).

1.4.3 Concerning Claim 14

The additional feature of claim 14 is identical to the feature of D1 that simulating the gamma ray emissions comprises simulating a low activity zone of the formation and calculating a first counting rate for the low activity zone, simulating a high activity zone of the formation and calculating a second counting rate for the high activity zone; and the API unit sensitivity factor is calculated based upon the first and second counting rates (see column 15, lines 26-31). Accordingly, claim 14 would have been obvious over D1 in view of D2. Therefore, claim 14 lacks an inventive step under PCT Article 33(3).

1.4.4 Concerning Claim 15

The additional features of claim 15 are characterized in that the functions performed by the processor further include functions to: calculate a tally multiplier for a model of a second blanket calibrator, based on the tally multiplier of the first blanket calibrator (hereinafter 'feature 15-1'); determine a thorium concentration corresponding to the tally multiplier of the model of the second blanket calibrator (hereinafter 'feature 15-2'); determine a material specification for the model of the second blanket calibrator, based on the thorium concentration (hereinafter 'feature 15-3'); simulate a counting rate for the second gammy ray tool, based on the tally multiplier and the material specification determined for the model of the second blanket calibrator (hereinafter 'feature 15-4'); and calculate the sensitivity factor for the second gamma ray tool, based on the counting rate simulated for the respective first and second blankets (hereinafter 'feature 15-5'). Features 15-1 and 15-4 would be easily conceived from D1 considering calculating a tally multiplier; and calculating the third counting rate of the second logging tool based on the tally multiplier (see column 11, lines 11-15, column 16, lines

Continued on The Next Page

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Previous Page

3-22), features 15-2 and 15-5 are identical to the features of D1 of obtaining a set of elemental concentrations included in the average elemental concentrations for the low and high activity zones; and calculating the API unit sensitivity factor, based on the counting rates determined (see column 9, lines 8-14, column 11, lines 21-27), and feature 15-3 would be easily conceived from D2 considering that the acoustic calibration apparatus may include the first material that has first known acoustic properties (e.g., simulating a solid) and the second material that has second known acoustic properties (e.g., simulating a liquid or gas) (see paragraph [0008]). Accordingly, claim 15 would have been obvious over D1 in view of D2. Therefore, claim 15 lacks an inventive step under PCT Article 33(3).

1.4.5 Concerning Claims 16-17

The additional features of claims 16-17 are identical to the features of D2 that the acoustic calibration apparatus (46) and a coupling device (47) may have a similar construction of cloth and belting materials to those of surface-based nuclear calibration blankets used to calibrate nuclear downhole tools (see paragraph [0035] and figures 1-2, 4). Accordingly, claims 16-17 would have been obvious over D1 in view of D2. Therefore, claims 16-17 lack an inventive step under PCT Article 33(3).

1.4.6 Concerning Claim 18

The additional feature of claim 18 is identical to the feature of D1 of simulating gamma ray emissions of a formation using Monte Carlo modeling (see column 3, line 25-column 4, line 2). Accordingly, claim 18 would have been obvious over D1 in view of D2. Therefore, claim 18 lacks an inventive step under PCT Article 33(3).

1.4.7 Concerning Claim 19

The additional feature of claim 19 is identical to the feature of D1 that version 4CP2 of MCNP may be applied for the calculations (see column 11, lines 6-10). Accordingly, claim 19 would have been obvious over D1 in view of D2. Therefore, claim 19 lacks an inventive step under PCT Article 33(3).

Continued on The Next Page

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of : Previous Page

1.5 Independent Claim 20

D1, which is considered to be the closest prior art to the subject matter of claim 20, discloses a computer-readable storage medium having instructions stored therein, which when executed by a computer cause the computer to perform a plurality of functions, including functions to: simulate gamma ray emissions of a formation and obtain a counting rate response of a first logging tool; compare the obtained counting rate with measured counting rates; and determine a second API unit sensitivity factor calculated using a third counting rate of a second logging tool (see column 3, line 25-column 4, line 2, column 11, lines 11-15, column 14, lines 7-23, column 15, lines 18-23, column 16, lines 11-22).

Claim 20 differs from D1 in that a computer-readable storage comprises functions to: when a simulated counting rate is determined to match a measured counting rate, determine a tally multiplier and a corresponding material specification for a model of a first blanket calibrator (hereinafter 'feature 20-1'); simulate a counting rate for a second gamma ray tool based on the tally multiplier and the material specification determined for the model of the first blanket calibrator (hereinafter 'feature 20-2'); and calibrate the second gamma ray tool according to a nominal blanket activity calculated from a sensitivity factor of the second gamma ray tool (hereinafter 'feature 20-3'). However, feature 20-1 would be easily conceived from the combination of D1 considering calculating a tally multiplier (see column 16, lines 3-10) and D2 considering that an acoustic calibration apparatus may include a first material that has first known acoustic properties (e.g., simulating a solid) and a second material that has second known acoustic properties (e.g., simulating a liquid or gas) (see paragraph [0008]). Features 20-2 and 20-3 would be easily conceived from D1 considering calculating the third counting rate of the second logging tool based on the tally multiplier; and calibrating the gamma ray logging tools using the simulated data of one or more activity zones (see column 1, lines 1-2, column 11, lines 11-15, column 16, lines 11-22), and D1 and D2 are concerned with mutually related technical fields.

Accordingly, claim 20 would have been obvious over D1 in view of D2. Therefore, claim 20 lacks an inventive step under PCT Article 33(3).

2. Industrial Applicability

Claims 1-20 meet the requirements of industrial applicability under PCT Article 33(4).