# Compilation of comments received on ISO/CD 16110-2

| Date:2006-11-08 | ISO/TC 197 doc. **N 362 Annex 1** |
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| **MB**[1] | **Clause No./ Subclause No./ Annex** (e.g. 3.1) | **Paragraph/ Figure/ Table/ Note** (e.g. Table 1) | **Type of comment**[2] | Comment (justification for change) by the MB | Proposed change by the MB | **Secretariat observations** on each comment submitted |
| JP | Overall<br>Or Foreword | | Ge | The following is stated in the foreword of this CD.<br>"ISO 16110-2 was prepared by …(omission)…….. .It based in part on <u>IEC 62282-3-2 fuel cell technologies-Part 3-2</u>: ………(omission)……….and uses <u>a similar approach</u> for measuring…(omission)…."<br>But there are several different approach in standpoint of the following issues;<br>1. The purpose of Test method for performance became not clear due to deleting the hydrogen product efficiency as test result.<br>2. The user whom this ISO will serve is not clear due to deleting Test classification (Type test, Routine test or Acceptance test)<br>3. The way of applying the uncertainty analysis is different from IEC 62282 due to application of it to estimate measured value instead of using it for performance calculated by measured values.<br>4. The classification of the test report is not clear, complex and requiring a lot to manufacturers or test agencies due to adding the nameplate furthermore, delete the option from three types of reports. | Propose to delete the statement indicated in the left side of this column and add the code of IEC62282-3-2 to the clause 2 Normative references as just reference if necessary. | |
| US | Scope | | GE | This International Standard provides test procedures for determining the performance of packaged, self-contained or factory matched hydrogen generation systems with a capacity less than 400 m3/h (n) at **0 °C** and 101,325 kPa, herein referred as hydrogen generators, that convert a fuel to a hydrogen rich stream of composition and conditions suitable for the type of device or process using the hydrogen (e.g. a fuel cell power system, industrial application or a hydrogen compression, storage and delivery system).<br><br>ISO is inconsistent with regards to the reference temperature for hydrogen. ISO uses 0, 15, 20, 21 and 25°C. Standardize! | Please standardize on **15°C.** TC 197 should at least be consistent with their own documents. | |

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| DE | 1 | | ge | The content of ISO 16110-2 is focused on fuel processors for pure hydrogen production (e.g. >99.5%H2). Recent developments of fuel processors in combination with fuel cells would be under the defined scope but their behaviour would not be precisely tested (e.g. CO / CO2-concentrations are not considered, anode-offgas-utilisation in the fuel processor is not considered). Hence, these fuel processors (product gas e.g. 75% H2, 20%CO2) should be excluded from the scope. | 1) The minimum capacity might be defined (e.g. 5m³/hr).<br>2) …herein referred as hydrogen generators, that convert a fuel to a hydrogen rich stream (>99.5 mol-% H2) of composition and conditions… | |
| JP | 3.1 | | Te | "Solid outputs" should be not defined.<br>Is "Solid outputs" different from "Particles" provided in the clause 4.3.1.1? | Particle such as carbon, catalysts and its support materials | |
| US | 3.1.1 | | ED | NOTE The hydrogen generator is composed of all or some of the following subsystems: a fuel processing system, **a fluid management system**, a thermal management system, and other subsystems needed. A generic hydrogen generator is shown in Figure 1.<br><br>Fluid management system is not defined nor is it noted in figure 1. | Define a fluid management system and add to figure 1 or drop reference to this term. | |
| US | 3.1.2 | | ED | **interface point** - measurement point at the **battery limit** of a hydrogen generator at which material and/or energy either enters or leaves.<br><br>What is a battery limit?  Is this term used in the document? | Define battery limit or drop reference to this term. | |

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| US | 3.1.3 | | TE | **storage state** - hydrogen generator being non-operational and possibly requiring, under conditions specified by the manufacturer, the input of thermal or electrical energy in order to prevent deterioration of the components.<br><br>What is this state? Is this a cold standby state where the water systems are charged and heated to a point above freezing or a state no energy is supplied? | Clearly define the state. Also refer to as state, storage so that all the states are grouped together | |
| US | 3.1.4 | | TE | **standby state** - hydrogen generator being at operating temperature and in an operational mode from which the hydrogen generator is capable of being promptly switched to an operational mode with net hydrogen output.<br><br>What is this state? Is this a hot standby (beds at temperature, no reformate generated) or an idle state (reformate generated with no net hydrogen produced supplied from the system) | Clearly define the state. Also refer to as state, standby so that all the states are grouped together. | |
| US | 3.1.5 | | TE | **start-up energy** - the sum of electrical, thermal, and / or chemical (fuel) energy required during the **start-up time**.<br><br>Start-up should be defined as a transition from a specific state to a second specific state. | Clearly define the transition states for start-up. Also refer to as time, start-up so that all the times are grouped together. | |
| US | 3.1.6 | | TE | **response time to rated hydrogen output -** duration between the instant when the step load change to rated power is initiated, and the first instant when this value is delivered.<br><br>Duration should be defined as a transition from a specific state to a second specific state. | Clearly define the transition states. | |

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| US | 3.1.7 | | TE | **cold state -** condition of a hydrogen generator at ambient temperature with no fuel or power input<br><br>What is this state? Is this a cold standby state where the water systems are charged and heated to a point above freezing or a state where the packed beds are heated? | Clearly define the state. Also refer to as state, cold so that all the states are grouped together. | |
| US | 3.1.8 | | ED | **audible noise level** | Suggest changing to **noise level, audible** | |
| US | 3.1.9 | | ED | **background noise level** | Suggest changing to **noise level, background** | |
| US | 3.1.15 | | ED | **return gas**<br><br>The industry usually refers to this as the tail gas. | Suggest adding "tail gas" into the definition. | |

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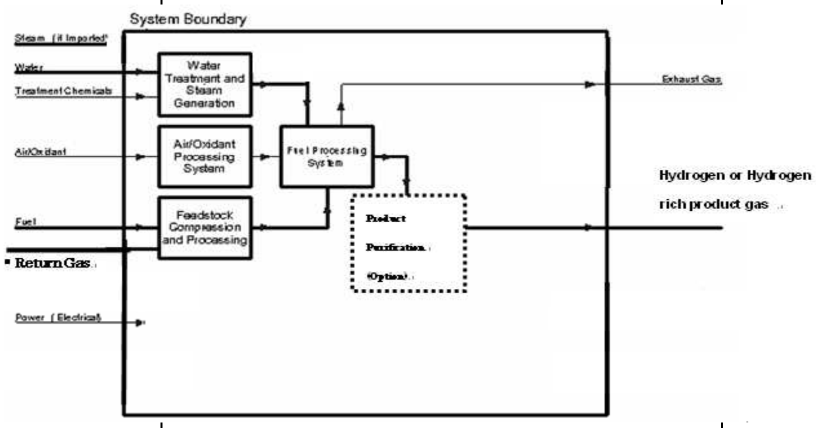
| JP | 3.2 | Figure1 | Te | Figure1 includes many interfaces, which are not provided in this draft text. These unnecessary ones for this standardization should be deleted, even if this figure is typical one. | The previous Figure 1 should be replaced with the new proposed Figure1 shown in below.<br><br><br>Figure1- Example of a hydrogen generator diagram | |
| US | 3.2 | Figure 1 | Ed | Fix so text is readable. Appears to be a problem introduced in the process of producing a PDF. | Fix figure text. | |
| US | 3.2 | Figure 1 | ED | Line weight for systems and subsystems indicated to be different in the figure note but are the same in the figure | Change line weights to match note. | |
| US | 3.2 | Figure 1 | ED | Arrows normally show flow direction. Note indicate that they only indicate measurement points.<br><br>This is confusing | Use arrows to note flow direction. Use an different symbol to indicate measurement point. | |

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| US | 3.3.1 | | GE | The reference conditions are specified as follows:<br><br>Reference temperature : t0 = 288.15 K (15℃)<br><br>Inconsistent with Scope but consistent with industry. | Change scope. | |
| AR | 4.2.1.1 | | Te | In the clause regarding composition of fluids, the composition of output hydrogen should be determined in agreement with ISO 14687 | Add the following text:<br>Output hydrogen composition shall be measured according to methods detailed in ISO 14687 | |
| AR | 4.2.1.1 | | Te | The standard 14687 should be referenced | Add the following standard to the reference list:<br>ISO 14687 - Hydrogen fuel. Product specifications | |
| US | 4.2.1.1 | 4.2.1.1 | Ed | Relative humidity is usually not directly measured as implied by the present text. | Change “only the relative humidity shall be measured” to “only the moisture content need be measured. The moisture content value may be calculated from other direct measurements (e.g., wet bulb and dry bulb temperatures) and reported as relative humidity.” | |
| US | 4.2.1.1 | | TE | Composition of Fluids<br><br>The test methods noted are suitable for measuring gross contaminants in natural gas. These methods are not suitable for trace impurities in reformate streams. | Use the methods for fuel supply. Test methods for reformate streams should be agree to between the manufacturer, certifying body and the customer. Test methods should be noted in the test report. Work is progressing with ASTM in the D03 committee on many of this topics. Contact Raul Dominguez of SCAQMD for details. | |
| US | 4.3.1.2.2 | | ED | Punctuation in first line of paragraph should be reviewed. | | |
| US | 4.3.1.3 | | ED | Punctuation in first line of paragraph should be reviewed. | | |
| JP | 4.4. | | te | Measurement of BOD is not necessary | Delete BOD from 4.4 d) | |

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| JP | 4.4.3 | | te | Measurement of BOD is not necessary | Delete 4.4.3 | |
| JP | 5 | Paragraph | Ge | "d) Uncertainty analysis" is provided.<br>Which performance is analyzed for?<br>Will all measured values be object for the uncertainty analysis? | It is unnecessary to analyse any measured temperature in the uncertainty. | |
| IT | 5.2 | | ge | Concerning the variation of $H_2$-impurities during load change, our suggestion is that guaranteed value has to be maintained under any plant conditions even during transitory operations. This is of course more stringent, in our opinion, that " 10% from the steady state value " | Delete "10% from their steady-state values" and substitute with "guaranteed value". | |
| JP | 5.2 | Table 1 | Ed | Note 1 which is added to the title name of the table-1, is not referred to anywhere. | Please check. | |
| JP | 5.2 | | te | In table 1,maximum permissible variations are applicable to steady-state, so reformers containing PSA(Pressure swing adsorption) system must be excluded. | Add Note to Table 1 that state reformers containing PSA(Pressure swing adsorption) system are excluded from the object of Table 1. | |
| US | 5.2 | | TE | Operating modes<br><br>... During transients measured during ramp up and down, impurity levels in the hydrogen product shall not increase more than 10% from their steady-state values....<br><br>Can manufacturers meet this requirement? What if a system designed to yield less than 1 ppm CO in the hydrogen has a brief spike of 2 ppm during a transient? Does this mean the system fails this requirement. | Reconsider the phrasing of the requirement. | |

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| US | 5.2 | Figure 2 | TE | Use figure in conjunction of state definitions in section 3. | | |
| US | 5.2 | a, b, c, e | TE | minimum rated output<br><br>What is minimum rated output? Is this an idle condition where some H2 is generated as tail gas for the reformer burner but no net hydrogen supplied? Is this no gross hydrogen generated? | Please define term and add to definitions and figure 2 | |
| US | 5.2 | g | TE | Standby state (hot hold)<br><br>See comments on 3.1.4 | | |
| US | 5.2 & 5.3 | Figure 2<br>Table 2 | te | Some of the fuel processors will likely be coupled with fuel cells. Some of the fuel cells will load follow to meet demand or for power factor correction with a fluctuating power factor. How is the information developed going to help me determine the performance of the fuel processor when operation maybe fluctuating between 30% and 100% of fuel/electrical output. I would suggest that the fuel processor be operated in steady state mode with the same measurements as at 100% output at 30%, 50% and 75% of full output. This would allow interpolation of output between levels and measure performance over time at various outputs at each state and the time it takes to change states. | The manufacturer will state minimum operational rating and perform tests similar to those in Table 2 for equipment that will provide hydrogen for a fuel cell that is capable of being used for load following. In this case, the steady-state and ramp conditions measured shall be expanded to include steady state conditions at 50% power and 75% power as well as for minimum output and maximum output. Ramping up will be performed between minimum output and 50% output, 50% output and 75% output, and 75% output and maximum output. Ramping down from maximum output will follow the same sequence. The output ramp up and down measurements will be made during this process and steady state conditions will be measured after each ramp step. The sequencing of fuel processor states during this test shall be:<br>Minimum steady state condition<br>Ramp up to 50% output<br>50% output steady state condition<br>Ramp up to 75% output<br>75% steady state condition | |

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| | | | | | Ramp up to 100% output<br>100% steady state condition<br>Ramp down to 75% output<br>75% steady state condition<br>Ramp down to 50% output<br>50% steady state condition<br>Ramp down to minimum output<br>Minimum steady state condition. | |
| IT | 5.3 | NOTE | ed | Missing reference for the note | The note has no reference, while it should be "Note 1", as reported in the heading of Table 1 | |
| JP | 5.3 | Table 2 | Te | What purpose is to measure Fluid inputs and Fluid outputs in all operation modes for? | Fluid inputs and outputs should be specified in concretely to calculate what is performed. And then it can be determined which mode they should be measured in. | |
| JP | 5.3 | Paragraph | Te | Regarding the uncertainty analysis, Annex A is referred and in the Annex A the hydrogen production efficiency is expressed as the performance test results many times. But this CD does not provide it in the text. | The test item of the hydrogen product efficiency seems to be not defined in this CD. If it is agreed, Annex A should be deleted. | |
| US | 5.3 | Table 2 | te | In Table 2 Test Items and System Status why is ramp rate data for electrical output and solids output excluded. It would seem that these would change as a function hydrogen output. The rate of change of the electrical response is critical to any load following application of the fuel processor integrated with a fuel cell. It depends on the maximum rate of change in hydrogen output by the fuel processor. | The table should include monitoring of solids output and electrical input during ramp up and ramp down. In addition a new column should be created for equipment capable of load following which measures maximum ramp up and ramp down during operation and includes measurement of all operational and emission values. | |

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| JP | 5.4.1 | Paragraph | Te | This requirement of "For measured values requiring multiple inputs, such as flow, care shall be taken to account for <u>the sum of the tolerances for all instruments</u>", is different from the meaning of the uncertainty analysis. | Deleted or discussed more about. | |
| IT | 6.2 | | te | There is no mention to the test period | We suggest to insert into the test plan the minimum duration of each test | |
| IT | 6.2 | | ge | General comment on flow fluctuation | Ramping up and down the capacity will be done at a rate which does not allow the system to fluctuate. Such fluctuation will be fixed and any excess will not allow in the control system to modify the capacity. This will move the fluctuation test into a load changing rate test under a stable environment, wouldn't it be better ? | |
| JP | 6.2 | Paragraph | Ed | The test plan of clause 4 is wrong.<br>"The clause 4 is "Measurement technique" | The test plan of Clause 5" is correct. | |
| JP | 6.2 | Paragraph | Te | f)…….(safe state) is correct?<br>What is the safe state? | The cold state is correct instead of "safe state"? | |
| US | 7.1.2 | 7.1.2.1<br>7.1.2.2<br>7.1.2.3<br>7.1.2.4<br>7.1.2.5 | TE | qmf is the mass flow rate of fuel; (kg/s)<br><br>q is usually used for volumetric and not mass flow rates.<br><br>m with a dot over it is usually used for mass flow rates | Please conform to best practices to avoid unnecessary errors. | |
| JP | 7.1.4（New Clause） | | te | The hydrogen product efficiency provided in the original draft has been deleted in the CD. | ***Mentioned below are supplementary comments to the former Japanese comments. The other formula (2) should be complementary defined for the fuel cell field.*** | |

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| | | | | | Figure B-1 is provided for a general application calculated by the first formula in the Clause 7.1.4. The Hydrogen product efficiency is defined in 3.1.4 /Clause 3.1 Terms and Definitions, and the formula is indicated as follows, in the Clause 7.1.4.<br>$\eta_h = \frac{Q_{out}}{Q_{in} + Q_{ret} + Q_{st} + P_{in}} \times 100$ ---(1)<br>The denominator of this formula includes all fuels fed to the test boundary, and in the case of that a part of the product Hydrogen as the return gas is fed, also the return gas should be included in the denominator.<br><br>And, the scope of this ISO/TC197/WG9 draft also includes application of fuel cell power system. Figure B-2 shows a test boundary as a Hydrogen generator excluding a fuel cell stack and auxiliaries related to it. In the case of fuel cell application, the following formula may be applied, if calculation condition is noticed or parties to the test are acceptable.<br>$\eta h = \frac{Oout - Qret}{Qin + Qst + Pin} \times 100$ ------(2)<br>The formula (2) is generally applied in the fuel cell field according to the following reason. The electrical efficiency $\eta_e$ is defined as follows in the fuel cell handbook.<br>$\eta_e = \eta_{Rf} \times \eta_{FC} \times \eta_{inv} \times (1 - \eta_{aux})$ (3)<br>$\eta_{Rf}$ **:** Reformer efficiency (Hydrogen production | |

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| | | | | | efficiency) is defined as follows<br>$$\eta_{Rf} = \frac{Q_{H2out} - Q_{H2\,Ret.}}{Q_{fin}}$$<br>$\eta_{FC}$ **:** DC Electrical efficiency of fuel cell stack is defined as follows<br>$$\eta_{FC} = \frac{Q_{cosum.H2}}{Q_{H2out} - Q_{H2\,Ret.}}$$<br>$\eta_{inv.}$ : DC/AC inverter efficiency<br>$\eta_{aux.}$ : Auxiliaries power consumption ratio<br>The formula (3) can be changed as follows,<br>$$\eta_e = \frac{Q_{H2out} - Q_{H2\,Ret.}}{Q_{fin}} \times \frac{Q_{consum.H2}}{Q_{H2out} - Q_{H2\,Ret.}} \times \eta_{inv} \times (1 - \eta_{aux.})$$<br>and more,<br>$$= \frac{Q_{consum.H2}}{Q_{fin}} \times \eta_{inv} \times (1 - \eta_{aux.}) \text{ --(4)}$$<br>This formula is theoretically right.<br>In conclusion, | |

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| | | | | | The formula (1) is defined as the basic calculation of “Hydrogen production efficiency”, and the other formula (2) is also defined for the fuel cell field, where a reformer unit is dealt with. | |
| JP | 8 | | ge | Test report must contain table which summarize the performance test result. | Add table listed in attached file to Chapter 8 | |
| JP | 8 | Paragraph | Te | The word order of “Test report and system nameplate” does not coincide with the order of section in the text. | “System nameplate and test report and” is correct?<br>Which is correct?<br>And which of “nameplate” or “system nameplate” is correct? | |
| JP | 8.1 | Paragraph | Te | “Nameplate” is common in your country or the EU? | The nameplate is known as a metal plate attached to the products, which indicates product date, product serial number, type, manufacturer and so on. | |
| JP | 8.1 | Paragraph | Te | What is the fluctuation? | Pressure fluctuation is the deviation from their average value of their measurements or its width? It is deviation among the averages of measured values during several durations? Definition of it is needed. | |
| JP | 8.1 | Paragraph | Te | Fluid outputs, system output and product output are different meaning from each other? | Fluid seems to be fuel, air, water and etc. fed to the system, and product output is hydrogen and others are what?  How about the system outputs? | |
| JP | 8.1 | Paragraph | Te | 3) Product out put at <u>minimum online state</u><br>What is the word of “online state”?<br>It is an operating state? | New terms should be defined or common word defined by ISO vocabulary or IEV should be applied. | |

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| JP | 8.4 | Paragraph | Te | The nameplate information includes many items of Title page and Summary report. Furthermore it includes new items.<br>The necessity of the nameplate cannot be understood. | The nameplate should be deleted. | |
| JP | 8.4 | Paragraph | Te | ", the nameplate information for the unit tested."<br>Since this CD does not specify test purpose, it may be misunderstood that all unit tested will be applied. | Should be revised as follows; "The specified unit tested for representative of the model." | |
| US | 8.5 | | TE | Detailed report | Please include the gas analysis results, methods used, and the lower detectable level obtainable for the species tested | |
| JP | A.1 | Paragraph | Ge | As mentioned in my comment No.6,<br>The contents regarding to "Hydrogen production efficiency and heat recovery efficiency and so on" is not provided in this text. | If efficiency as test performance is not described, delete this comment on regarding of "Hydrogen product efficiency". | |
| JP | A.2 | Paragraph | Ge | As the same comment on A.1 mentioned in my comment No.18<br>Hydrogen product efficiency is not provided in this CD. | If efficiency as test performance is not described, delete this comment on regarding of "Hydrogen product efficiency". | |

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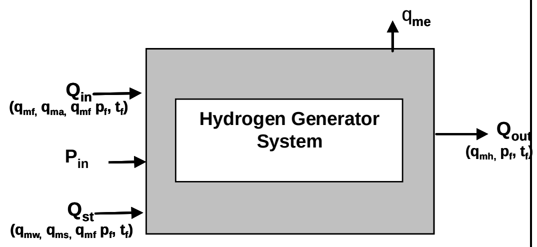
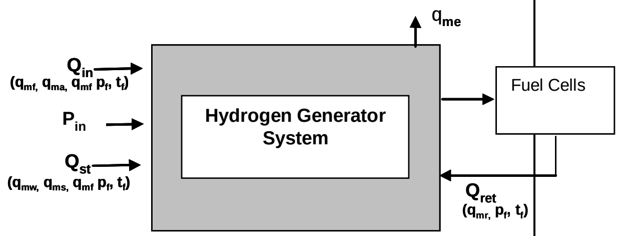
| US | A.3 | Annex A, Section A.3 | Te | Limiting the systematic error to calibration error or accuracy of the instrument neglects several common systematic errors that should be addressed. | Change "systematic uncertainty is defined as the calibration error or accuracy of an instrument" to "systematic uncertainty is defined as the estimate of errors that remain constant during the test process. The systematic uncertainty estimate should consider calibration error, instrument installation effects (e.g., temperature probe radiation), and input data (e.g., gas properties measured as part of test protocol but not measured continuously during entire test process)." | |
| JP | A.4 | Paragraph | Ge | As the same comment on A.1 and A.2 mentioned in my comment No.18 and 19, the hydrogen product efficiency is not provided in this CD. | If efficiency as test performance is not described, delete this comment on regarding of "Hydrogen product efficiency". | |
| JP | Annex B | | Ge | The table of "Symbols and abbreviated terms" includes many terms not used in the text. | Delete them. | |
| JP | Annex B | Table B.1 | Ed | Table BB.1 is wrong. | Table B.1 is correct. | |
| JP | Annex B | Figure B | Te | Figure B is applied as visual one so that measured values used to the formulas defined in the text can be understood correctively on relationship between each symbol within the test boundary | Should be revised to appropriate one which fluid output/input, product outputs and system outputs are shown in an explicit way.<br>If no calculation using measured values, it is unnecessary. Delete a diagram like this. | |

| Date:2006-11-08 | ISO/TC 197 doc. **N 362** **Annex 1** |
|---|---|
| | Reference Document: ISO/TC 197 doc. **N 351** ISO/CD16110-2 ( |

## Compilation of comments received on ISO/CD 16110-2

| 1 | 2 | (3) | 4 | 5 | (6) | (7) |
|---|---|---|---|---|---|---|
| **MB**[1] | **Clause No./ Subclause No./ Annex** (e.g. 3.1) | **Paragraph/ Figure/ Table/ Note** (e.g. Table 1) | **Type of comment**[2] | Comment (justification for change) by the MB | Proposed change by the MB | **Secretariat observations** on each comment submitted |
| JP | Annex B | Figure B | Te | If some formulas will be defined as calculating fuel efficiency, figure B-Symbol diagram should be revised to appropriate one.<br>In the comment No.10 regarding to the Hydrogen product efficiency, two types of formula are defined. If agreed, appropriate ones should be made. | If no formula, delete the diagram indicated in the CD.<br><br>FigureB-1 and FigureB-2 shown below will be proposed corresponded to the formula (1) and (2) shown the comment No.10.<br><br>Figure B-1 —Symbol diagram(General Application)<br><br>Figure B-2 —Symbol diagram(Fuel Application) | |