GTR Phase 2 on FCEV
Brussels, Belgium
October 17-19, 2017

ISO/TC 197 Standardization Efforts on H2 Fueling Infrastructure and Vehicular Components

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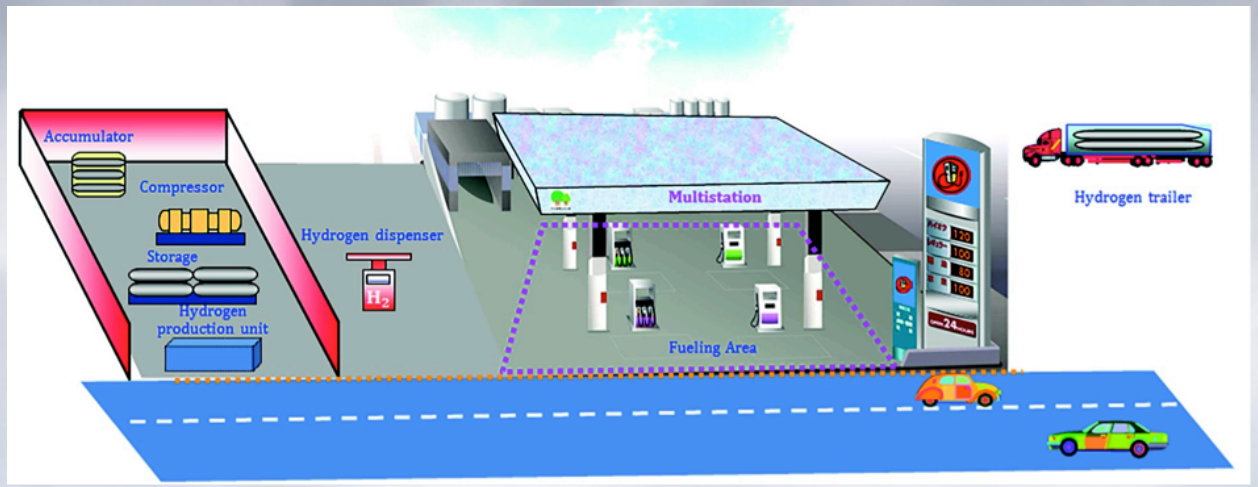
H_2 Integration into Retail Stations Works!

FCEV safety is affected by external environment!



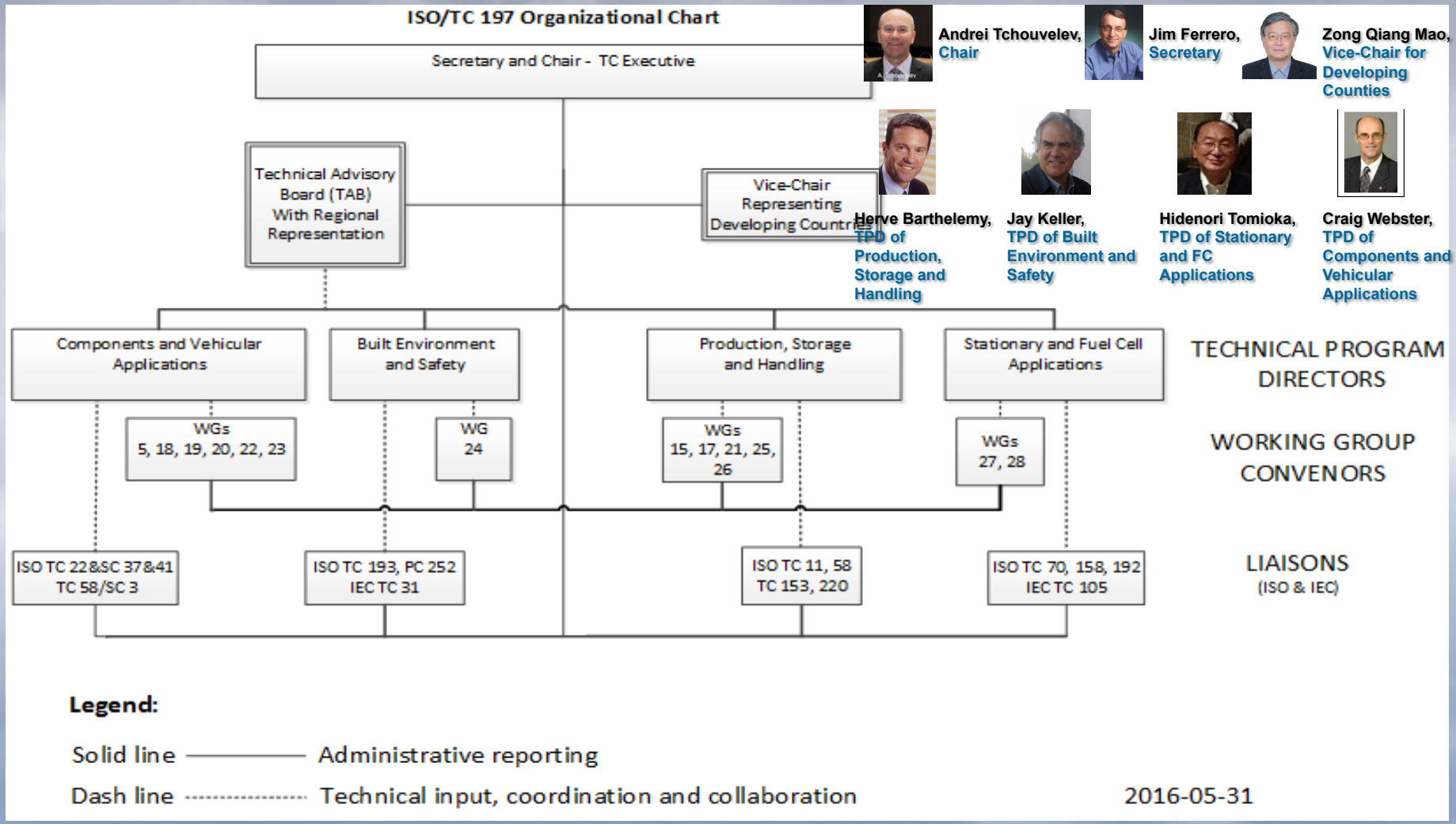
Hamburg, Germany

Munich, Germany

Karlsruhe, Germany

ISO/TC 197 Scope and Structure

Standardization in the field of systems and devices for the production, storage, transport, measurement and use of hydrogen.

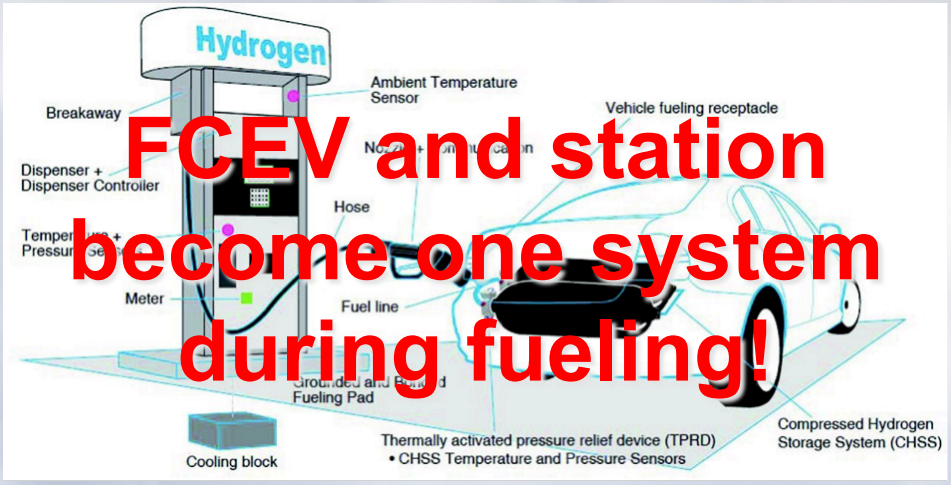


ISO/TC 197 Current Work Program

13 **Active** WGs (October 2017)

Fuel Quality
WG 27
ISO 14687 Rev

Active Collaboration
CEN/CENELEC
TC 268/WG5, TC 6



FCEV and station become one system during fueling!

Vehicle Components

Fueling Connectors WG 5
ISO 17268 Rev

On-board Storage WG 18
ISO 19881

TPRD WG 18 ISO 19882

Storage Technologies

GH_2 Ground Storage WG 15 ISO 19884

Me-Hy Portable Storage WG 25 ISO 16111 Rev

Electrolysers
WG 26
ISO 22734 Rev

Fueling Family ISO 19880

-1: HFS Gen'l Req'ts WG 24
-2: Dispensers WG 19
-3: Valves WG 20
-4: Compressors WG 21
-5: Hoses WG 22
-6: Fittings WG 23
-7: Reserved
-8: Fuel Quality Control WG 28

ISO 17268 Revision Status

Gaseous hydrogen land vehicle refuelling connection devices

DIS Ballot successful (13 Approve, 0 Disapprove, 7 Abstain)

Comments to be addressed at next WG 5 meeting (Nov. 17, 2017 – Torrance, CA)

New technical content over previous (second) edition:

- **Testing of communication hardware**
- **Evaluation of nozzle freeze-lock**
- **Evaluation of user abuse effects**

ISO 19881 and ISO 19882 Status

ISO 19881 Land vehicle fuel containers

DIS Ballot successful (10 Approve, 3 Disapprove, 7 Abstain)

Comments to be addressed at next WG 18 meeting

Technical content:

- **Category A – Containers for LD and HD applications**
- **Category B – Type 4 containers for LD applications per UN GTR 13**
- **Category C – Containers for industrial trucks, forklifts**

ISO 19882 Thermally activated PRDs

DIS Ballot successful (12 Approve, 0 Disapprove, 8 Abstain)

Comments to be addressed at next WG 18 meeting

Technical content:

- **Harmonized with UN GTR 13 with minor exceptions**

ISO 14687-2 Revision Status – Fuel Quality

Characteristics (assay)	Type I, Type II Grade D
Hydrogen fuel index (minimum mole fraction)[a]	99,97 %
Total non-hydrogen gases	300 µmol/mol
Maximum concentration of individual contaminants	
Water (H_2O)	5 µmol/mol
Total hydrocarbons[b] (Methane basis)	2 µmol/mol
Oxygen (O_2)	5 µmol/mol
Helium (He)	300 µmol/mol
Total Nitrogen (N_2) and Argon (Ar)[b]	100 µmol/mol
Carbon dioxide (CO_2)	2 µmol/mol
Carbon monoxide (CO)	0,2 µmol/mol
Total sulfur compounds[c] (H_2S basis)	0,004 µmol/mol
Formaldehyde (HCHO)	0,01 µmol/mol
Formic acid (HCOOH)	0,2 µmol/mol
Ammonia (NH_3)	0,1 µmol/mol
Total halogenated compounds[d] (Halogenate ion basis)	0,05 µmol/mol
Maximum particulates concentration	1 mg/kg

A.1 For the constituents that are additive, such as total hydrocarbons and total sulfur compounds, the sum of the constituents shall be less than or equal to the acceptable limit. The tolerances in the applicable gas testing method shall be the tolerance of the acceptable limit.

A.1.1 [a] The hydrogen fuel index shall be determined by subtracting the "total non-hydrogen gases" in this Table, expressed in mole percent, from 100 mole percent.

A.1.2 [b] Total hydrocarbons include oxygenated organic species. Total hydrocarbons shall be measured on a carbon basis (µmolC/mol). Total hydrocarbons may exceed 2 µmol/mol due only to the presence of methane, in which case the summation of methane, nitrogen and argon shall not exceed 100 µmol/mol.

A.1.3 [c] As a minimum, total sulphur compounds shall include H2S, COS, CS2 and mercaptans, which are typically found in natural gas.

A.1.4 [d] Total halogenated compounds include, for example, hydrogen bromide (HBr), hydrogen chloride (HCl), chlorine (Cl2), and organic halides (R-X).

2012 Published version

Constituents (assay)	Type I, Type II Grade D
Hydrogen fuel index (minimum mole fraction)[a]	99,97 %
Total non-hydrogen gases	300 µmol/mol
Maximum concentration of individual contaminants	
Water (H_2O)	5 µmol/mol
Total hydrocarbons except methane[b] (C1 equivalent)	2 µmol/mol
Methane (CH_4)	100 µmol/mol
Oxygen (O_2)	5 µmol/mol
Helium (He)	300 µmol/mol
Nitrogen (N_2)	300 µmol/mol
Argon (Ar)	300 µmol/mol
Carbon dioxide (CO_2)	2 µmol/mol
Carbon monoxide (CO)[c]	0,2 µmol/mol
Total sulfur compounds[d] (S1 equivalent)	0,004 µmol/mol
Formaldehyde (HCHO)[c]	0,2 µmol/mol
Formic acid (HCOOH)[c]	0,2 µmol/mol
Ammonia (NH_3)	0,1 µmol/mol
Halogenated compounds[e] (Halogen ion equivalent)	0,05 µmol/mol
Maximum particulate concentration[f, g]	1 mg/kg

For the constituents that are additive, such as total hydrocarbons and total sulfur compounds, the sum of the constituents shall be less than or equal to the acceptable limit.

[a] The hydrogen fuel index is determined by subtracting the "total non-hydrogen gases" in this table, expressed in mole percent, from 100 mole percent.

[b] Total hydrocarbons except methane include oxygenated organic species. Total hydrocarbons shall be measured on a C1 equivalent (µmolC/mol).

[c] Sum of CO, HCHO, HCOOH shall not exceed 0.2 µmol/mol.

[d] As a minimum, total sulfur compounds include H_2S, COS, CS_2 and mercaptans, which are typically found in natural gas.

[e] Halogenated compounds include, for example, hydrogen chloride (HCl) and organic halides (R-X). Halogenated compounds shall be measured on a halogen ion equivalent (µmol/mol).

[f] Particulate includes solid and liquid particulates. Large particulates can cause issues with vehicle components and should be limited by using filter as specified in ISO19880-1 and ISO19880-8,

[g] Particulate includes oil mist. No visible oil shall be found in fuel at a nozzle.

Agreement with EIGA

Particulates

2017 CD2 version in ballot – closes on Oct 14th

ISO 19880-8 Status – Quality Control

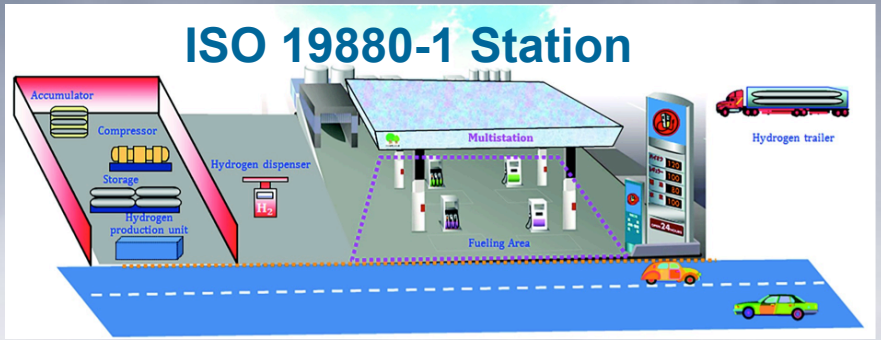
Table 4—Impact of impurities on fuel cell powertrain

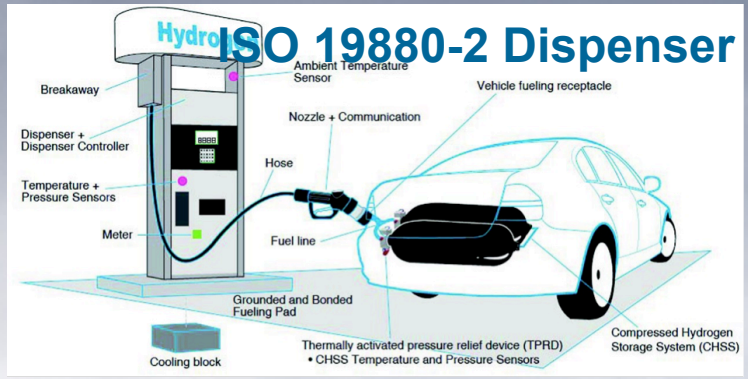
Impurity		Severity Class for 0 ppm ≤ Concentration < ISO Value	ISO 14687-2 Threshold Value[2] [ppm]	Severity Class for ISO Value ≤ Concentration < Level 1 Value	Level 1 Value [ppm]	Severity Class for Level 1 Value ≤ Concentration ≤ 100%
Total non-H_2 gases		0	300	1	300	4
Total Nitrogen and Argon	N_2, Ar	0	100	1[3]	300[3]	4
Oxygen	O2	0	5	No test data available	No test data available	Without test data for proposed level 1 value validation already SC4 if ISO Spec exceeded
Carbon dioxide	CO_2	0	2	1	3	4
Carbon monoxide	CO	0-2	0,2	2-3[4]	1	4
Methane	CH_4	0	100	1	300	4
Water	H_2O	0	5	4	NA	Already SC4 if ISO Spec exceeded
Total sulfur compounds	H_2S basis	0-4	0.004	4	NA	Already SC4 if ISO Spec exceeded
Ammonia	NH_3	0	0.1	4	NA	Already SC4 if ISO Spec exceeded
Total hydrocarbons	CH_4 basis	0-4	2	1-4[4]	NA	Already SC4 if ISO Spec exceeded
Formaldehyde	CH_2O	0	0.01	2-3[4]	1	4
Formic Acid	CH_2O_2	0-2	0.2	2-3[4]	1	4
Total halogenated compounds		0-4	0.05	4	NA	Already SC4 if ISO Spec exceeded
Helium	He	0	300	1	300	4
Maximum particulates concentration (liquid and solid)		0-4	1 mg/kg	4	NA	Already SC4 if ISO Spec exceeded

SEVERITY CLASS	FCEV Performance impact or damage
0	• No impact
1	• Minor impact • Temporary loss of power • No impact on hardware • Vehicle still operates
2	• Reversible damage • Requires specific procedure, light maintenance. • Vehicle still operates.
3	• Reversible damage • Requires specific procedure and immediate maintenance. • Gradual power loss that does not compromises safety
4	• Power loss or Vehicle Stop that compromises safety • Irreversible damage • Requires major repair (e.g. stack change)

2017 DIS passed with no negative votes

ISO 19880-1 & 2 Status





TECHNICAL SPECIFICATION ISO/TS 19880-1

First edition
2016-07-01

Gaseous hydrogen — Fuelling stations —

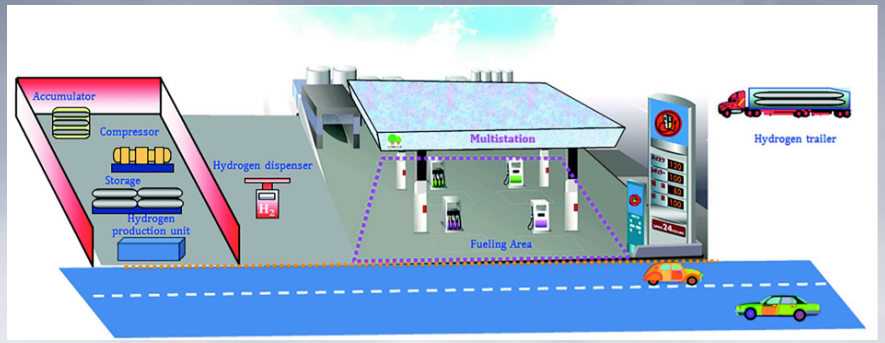
Part 1:
General requirements

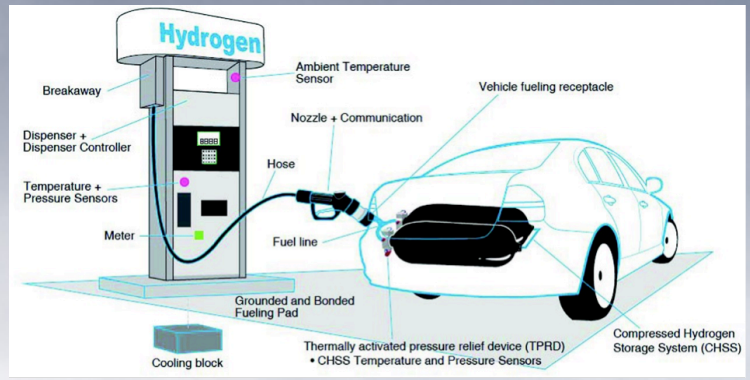
Carburant d'hydrogène gazeux — Stations-service —
Partie 1: Exigences générales

- TS published in July 2016
- CD2 passed in June 2017 with no negative votes
- Pre-DIS (Post CD2) – Sept 2017

- Used ANSI/CSA HGV4.1 and 4.4 as seed documents
- SAE J2601 is a normative reference
- DIS passed in Sept 2017 with 4 negative votes
- Decision to postpone the finalization of ISO 19880-2 via DIS2 until after ISO 19880-1 reaches FDIS stage – expected end of 2018

ISO 19880-1 Pre-DIS (CD2 Post) Draft





12.5 Fueling safety and performance functional testing

Testing shall verify that the hydrogen fueling station meets the manufacturer's specification, the requirements in Chapter 8, and the requirements of the fuelling protocol using an approved protocol validation standard such as CSA HGV 4.3, or using the guidance in Annex B to develop an approval process.

Annex B
(informative)

Hydrogen Fueling Verification of the SAE J2601 Fueling Protocol and SAE J2799 Communications

- SAE J2601 establishes the protocol and process limits for hydrogen fueling of light duty vehicles which meet the requirements of the GTR 13.

- For validation of fueling stations employing SAE J2601 and SAE J2799, an approved validation standard, such as CSA HGV 4.3, should be used.

ANSI/CSA HGV4.3 Station Dispenser Validation

Hydrogen Dispenser Performance, Accuracy and Fuel Quality

Performance validation to SAE J2601 and SAE J2799

- **25kg onboard hydrogen storage at 70MPa NWP**

Accuracy validation per Weights and Measures

Fuel Quality validation per SAE J2719 / ISO 14687-2 (coming soon)

Summary and Recommendation

- FCEV safety considerations need to include complex external environment of a multifuel station
- When FCEV is connected to a dispenser, its CHSS becomes part of a single system with the station
- THUS FCEV safety and performance are dependent upon:
  - ✓ Fuel quality and quality control
  - ✓ Fueling protocol / dispenser performance validation
- **Recommendation**: GTR2 needs to reference relevant ISO/TC 197 standards for station, dispenser, fuel quality and quality control, and fueling connector standards.

Thank you for your attention!

Hydrogen cooling the Earth

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