

GAR Certification of H2NG appliances

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Key elements for H2NG appliances complying with the GAR: The Risk Analysis (RA)

- ER 1.2 “**The manufacturer** must identify and **analyze the risks** that apply to his appliance. He shall then design and construct it taking into account its risk assessment.”
- ER 1.3 “In selecting the most appropriate solutions, the manufacturer shall apply **the principles** in the following order:
 - (a) **eliminate** or reduce risks as far as possible (inherently safe design and construction);
 - (b) take the necessary **protection measures** in relation to risks that cannot be eliminated;
 - (c) **inform users** of the residual risks due to any shortcomings of the protection measures adopted and indicate whether any particular precautions are required.

Key aspects for H2NG compared to NG-only.

- The warning notices stating the **type of gas** to be used, the **appliance category** and any restrictions on use, to ensure that the risks are minimized. (ER 1.6.3)
- The instructions for **installation, adjustment** and servicing (ER 1.6.1) that have impact on the appliance settings in the field.
- Stable ignition (ER 3.3) and combustion process(ER 3.4.1) : (**Light back** of partially premixed burners, **Overheating** of fully premixed burners, **incomplete combustion**): Consider here the **instructions for adjustment** using the range of gases the appliance is designed for once the appliance is installed and adjusted.
- **Materials** of the appliance and fittings suitable for H2 (ER 2).
- **Risks Identified from the RA** : fan location, ionization current , delayed ignition, surface temperature of the burner and its surroundings.

The **type of gas** to be used, the gas supply pressure, the **appliance category**.

- The warnings, instructions and the design documentation must be clear on:
 - ❑ The Wobbe bandwidth (or Wobbe range) of the gas and
 - ❑ the range of hydrogen concentration the appliance is designed for.
- It is suggested to use two parameters : Yyy and Zzz .
 - ❑ Zzz specifies the Wobbe bandwidth without hydrogen (the base NG) the appliance is designed for in MJ/m³ divided by 10. (Z20 means the Wobbe bandwidth is 2,0 MJ/m³).
 - ❑ Yyy specifies the H₂ concentration of the gas expressed in %v/v (Y20 means that the appliance is designed for gases that may contain between 0 and 20% H₂)

Wobbe bandwidth (intermezzo)

- The Wobbe bandwidth intended is the difference between the top and bottom Wobbe Indices (at 15/15) for the distributed gas on a specific location WITHOUT hydrogen. (The NG-only part of the H2NG)
- Today's appliance standards are based on the experience that the gas supplied has only a narrow Wobbe bandwidth. ("no gas quality variations to a large extend")
- SFG GQS is looking for standardisation of distribution gasses based on the Wobbe bandwidth.
- The SFG GQS study reveals that most of the 250 NG grids investigated have a bandwidth below 2,0 MJ/m³ (Z20) , sum go up to 3,7 MJ/m³ (Z37), extremes like 5,7 MJ/m³ (Z57) do occur.

Appliance category and testgas ID suggestions.

- It is suggested to use the two parameters : Y and Z .
 - I_{2E} can become $I_{2EYyyZzz}$ (For example $I_{2EY20Z20}$ or $I_{2EY20Z37}$)
 - I_{2H} can become $I_{2HYyyZzz}$ (For example $I_{2HY20Z20}$ or $I_{2HY20Z37}$)
- For appliances designed for a small Wobbe bandwidth the Z can be left out :
 - I_{2E} can become I_{2EYyy} (For example I_{2EY20})
 - I_{2H} can become I_{2HYyy} (For example I_{2HY20})
- For test gases the shorthand can be used as well: GggYyy is the testgas Ggg where hydrogen is added so that the hydrogen content is increased by yy% points. For example $G222_{Y20}$ is a methane/hydrogen mixture containing $(23+20=)$ 43% hydrogen.

Installation & adjustment instructions.

- It is suggested not to adjust based on the CO₂ but on the O₂ content.
- Make an assessment on how likely it is that the appliance is adjusted using the actual distribution gas considering :
 - ❑ National requirements on CO emissions
 - ❑ National requirements on flue losses
 - ❑ Will National requirements recommending non –adjustment of appliances be followed?
- Adjustment instructions could be improved if the actual accurate information on the Wobbe index of the NG-only gas and the H₂ content is available on a city by city basis for installers. (This is not the case today !).

Adjustments of the appliance in the field;

- **If adjustments in the field are likely: Test for the 2 most extreme reasonably foreseeable adjustments using the actual distribution gas. This means (See also TC109 proposal):**
 - 1. A high lambda setting using the highest Wobbe distribution gas at the highest O2 level indicated in the instructions and adding 1% of O2 of mal-adjustment. Then test Using the Low Wobbe Test Gases.**
 - 2. A low lambda setting using the lowest Wobbe distribution gas with the maximum H2 content at the lowest O2 level indicated in the instructions and subtracting 1% of O2 for mal-adjustment. Then test Using the High Wobbe Test Gases**

Stable ignition (ER 3.3) and combustion process(ER 3.4.1): Test gases & safety margin

- The current test gases containing hydrogen are used to ensure a safety margin for burning gases not contain hydrogen (NG-only). This safety margin is needed for wear & tear and variations in climatic conditions.
- The design documentation shall either:
 - 1) Provide evidence that a similar safety margin is ensured for a H2NG appliance or
 - 2) provide evidence that the safety margin provided by the current test gases are over the top. This evidence means that the test gases for NG-only appliances can therefore be made less severe.

Stable ignition (ER 3.3) and combustion process(ER 3.4.1).: Test gases & safety margin

- For a I_{2EY20Z20} appliance a similar safety margin would result in using :
 - ❑ G₂₀_{Y20} as a second reference gas for setting the appliance besides G20
 - ❑ G₂₂₂_{Y20} and G₂₄_{Y20} besides G222 and G24 as second light back gas and overheating gas.
- For a I_{2EY20Z57} appliance a similar safety margin would be more complicated.
 - ❑ The impact of the Wobbe bandwidth of 5,7 MJ/m³ (of the NG-only gas) must be assessed as well.
 - ❑ This assessment will depend on the adjustment instructions, the mixing- and burning technology used.

Some risks identified from the Risk Analysis (RA):

- Location of the fan (risk of ignition if the fan is in the premixed gas and air)
 - ❑ See what happens if the mixture ignites.
- Flame supervision (ionization current decreases with increasing H₂ concentration)
 - ❑ Analyze the impact.
- Delayed ignition: Risk increases with increasing H₂ concentration.
 - ❑ Do the test!
- Surface temperatures of the burner and its surroundings.
 - ❑ Most relevant for fully premixed appliances burning in the “red flame mode”
 - ❑ Determine what impacts these temperatures (Often the combustion temperature and therefore the lambda is the key factor)

Conclusion:

- The instructions must be clear on the gasses the appliance is designed for (The Y and the Z are a option for this).
- The manufacturer must provide a risk analysis (RA) using the gasses the appliance is designed for.
- For H2NG evidence must be given that the ER's of the GAR and the risks form the RA are covered to the same extend as for NG-only appliances.
- ❑ Key issues indicated by the ER's: On site adjustment of the appliance, ignition and combustion stability, Materials suitable for H2 .
- ❑ Some key issues form the RA: Fan location, Delayed ignition , Ionization current, Surface temperatures of the burner and its surroundings.

Recommendation for the future of H2NG

- Introduction of H2NG is supported if:
 - ❑ The actual accurate information on the Wobbe index of the NG-only gas and the H2 content are available on a city by city basis to the public and the installers. (This is not the case today !)
 - ❑ This may require modifications of the National legislation on DSO and TSO in each member state that considers introducing H2NG.
 - ❑ If national legislation is in place to provide this information, the adjustment instructions of the manufacturer may assume that this information is available to the installer and use this information as the basis for the installation instructions. (Today it is not reasonable to assume that this information is available for the installer)