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شرکت ملی گاز ایران
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IGS

مشخصات فنی

کیفیت سامانه فعال قطع گاز در ایستگاه های TBS/DRS در مقابل زلزله

Seismic Qualification of Active Shut-off System for DRS/TBS Against Earthquake

ابلاغ مصوبه هیأت مدیره

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باسلام،

به استحضار می‌رساند در جلسه ۱۹۲۷ مورخ ۱۴۰۰/۰۳/۲۳ هیات مدیره، نامه شماره گ۳۲۸۰۷/۰۰۰/۹ مورخ ۱۴۰۰/۰۳/۱۷ آن مدیریت درمورد تصویب نهایی مقررات فنی شرکت ملی گاز ایران به شرح زیر مطرح و مورد تصویب قرار گرفت.

۱-مشخصات فنی کنتور گاز آلتراسونیک چند مسیره IGS-M-IN-104(3)

۲-دستور العمل عمل کننده هیدرولیکی شیرآلات IGS-M-IN-304(2)

۳-مشخصات فنی کیفیت سامانه قطع گاز در ایستگاه های TBS/DRS در مقابل زلزله IGS-M-IN-306(1)

۴-مشخصات فنی فلنج های مهار (Anchor Flang) IGS-M-PL-027(1)

این مصوبه در حکم مصوبه مجمع عمومی شرکت‌های تابعه محسوب و برای کلیه شرکت‌های تابعه لازم الاجرا می‌باشد .

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Foreword

This standard is intended to be mainly used by NIGC and contractors, and has been prepared based on interpretation of recognized standards, technical documents, knowledge, backgrounds and experiences in natural gas industry at national and international levels.

Iranian Gas Standards (IGS) are prepared, reviewed and amended by technical standard committees within NIGC Standardization division and submitted to the NIGC's "STANDARDS COUNCIL" for approval.

IGS Standards are subject to revision, amendment or withdrawal, if required, thus the latest edition of IGS shall be checked/inquired by NIGC employees and contractors.

This standard must not be modified or altered by NIGC employees or its contractors. Any deviation from normative references and / or well-known manufacturer's specifications must be reported to Standardization division.

The technical standard committee welcomes comments and feedbacks about this standard, and may revise this document accordingly based on the received feedbacks.

General Definitions

Throughout this standard the following definitions, where applicable, should be followed:

1- "STANDARDIZATION DIV." is organized to deal with all aspects of industry standards in NIGC. Therefore, all enquiries for clarification or amendments are requested to be directed to mentioned division.

2- "COMPANY": refers to National Iranian Gas Company (NIGC).

3- "SUPPLIER": refers to a firm who will supply the service, equipment or material to IGS specification whether as the prime producer or manufacturer or a trading firm.

4- "SHALL ": is used where a provision is mandatory.

5- "SHOULD": is used where a provision is advised only.

6- "MAY": is used where a provision is completely discretionary.

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Contents

1. SCOPE

This Standard provides the minimum requirements and guidelines for the qualification of system whose function is required to ensure the safe response of active shut-off systems for DRS/TBS against earthquakes. In addition to requirements and guidelines put forth in this Standard, the mechanical and electrical equipment used in active shut-off system shall comply with other requirements of the applicable design and construction codes and standards of National Iranian Gas Company (NIGC).

2. REFERENCE

ASME QME-1–2012, Qualification of Active Mechanical Equipment Used in Nuclear Facilities

IEEE Std. 344TM-2013, IEEE Standard for Seismic Qualification of Equipment for Nuclear Power Generating Stations.

3. DEFINITIONS

3.1 Functionality

Ability of components to perform the electrical and mechanical motion required to fulfill its specified function when subjected to the severe conditions including large earthquake (LE).

3.2 Earthquake Vibration

Earthquakes produce three-dimensional (3D) random ground motions that are characterized by simultaneous but statistically independent horizontal and vertical components. Duration of strong motion of the earthquake may last from 10 second to 15 second, although the duration of event may be longer. The ground motion encompasses a lot frequency range which the damaging motion dominantly have frequency between 1 to 33 Hz.

3.3 Large Earthquake (LE)

An earthquake which has considerable risk and damage to urban gas facilities is Known as Large Earthquake. In the context of this standard, Maximum Credible Earthquake (MCE) is considered to be Large Earthquake.

3.4 Operating Basis Earthquake (OBE)

An earthquake that is smaller than LE and expected to occur at the site of interest during the operating life time of equipment. Due to the ground motion of the OBE earthquake, the

gas regulating stations should remain functional without risk to the health and safety of the public.

3.5 Spectral Intensity

The area under the relative-velocity response spectrum with 5% damping ratio between the periods of 0.1 second and 2.5 second, divided by the period interval.

3.6 Response Spectrum:

A plot of the maximum response of a single degree of freedom system to the base excitation, as a function of natural frequency of system and damping.

3.7 Required Response Spectrum (RRS):

The response spectrum of large earthquake (LE) and operating base earthquake (OBE) which are used for assessing the performance of active shut-off systems of DRS/TBS. Response spectrum of LE and OBE are determined based on the hazard analysis on the site for return periods of 2475 and 475 years, respectively. These spectrums shall be determined and approved by the National Iranian Gas Company (NIGC).

3.8 Test Response Spectrum (TRS)

The response spectrum of the time history of the motion of shaking table.

3.9 Time History

A time history displays the earthquake-induced motion (usually in terms of acceleration) as a function of time.

3.10 Safety-Integrity Levels

These integrity targets are known as ‘safety-integrity levels’ and are usually described by one of four discrete bands (SIL 1 to 4). SIL 4: the highest target and most Onerous to achieve, requiring state of the art techniques (usually avoided) and SIL 3: the less onerous than SIL 4 but still requiring the use of sophisticated design techniques. SIL 2: requiring good design and operating practice to a level not unlike ISO 9000. SIL 1: the minimum level but still implying good design practice. SIL 1: referred to (in IEC 61508 and other documents) as ‘not-safety related’ in terms of compliance.

4. GENERAL REQUIEMENTS

4.1 All technical documents of electrical and mechanical components of active shut-off system shall be provided before set up of tests by the vendors. These documents shall contain required details of the relevant equipment.

4.2 The active shut-off system shall be independent of other DRS/TBS equipment. The system shall have its own functionality during earthquake and react at the required set point. The earthquake shut off valves a part of the active system shall be installed on the main entrance of the station.

4.3 The earthquake shut-off system shall be resistant and functional against all consequence of earthquake such as fire, debris, structural failure of station.

4.4 In normal condition, any failure of shut-off system, including the electrical, mechanical and electronic components, shall be detected and reported automatically. No closure shall be done in failure of the system in normal condition.

5. Seismic Qualification Approach

The equipment seismic qualification shall show that equipment is remained functional when subjected to the forces resulting from LE. Moreover, the equipment must withstand against the effects of a number of small earthquakes prior to the occurrence of a LE. The most commonly used methods for seismic qualification are represented in subsequent sections. The methods are grouped into three general Categories as below:

a-Assess the equipment performance by analytical approaches.

b- Assess the equipment performance by testing under simulated seismic motions. Regardless of the qualification approach, reasonable criteria shall be set to show the functionality of the equipment in LE. The equipment performance shall be withstood up to damage level during LE.

*Here, the analytical approach is omitted due to its complicated models.

6. Testing

6.1 Introduction

In this section the acceptable procedures for testing the qualification of the equipment will be represented. Tests should be performed by subjecting equipment to ground motion that simulates the 3D or 2D nature of ground motion of a LE in manner that equipment installed in similar to the actual situation. The tested equipment shall not be applied in automatic shut-off system unless the proper performance of the equipment is proved through standard tests.

6.2 Mounting

The equipment to be tested shall be mounted on the shaking table in a manner that simulates the real condition of equipment in the field. The mounting method should be similar to the real condition in the field and should use the recommended bolt size, type torque, configuration, weld pattern and type, etc. in compliance with regulations and standards of NIGC.

The effect of electrical connections, conduit, sensing lines, and any other interfaces shall be considered and included in the setup unless otherwise justified. The orientation of the equipment during the test shall be documented. The results of test shall be represented only for one orientation unless adequate justification is provided to repeat the test for other orientation. The method of equipment mounting on the shaking table shall be documented, and a description of any interposing fixtures and connections shall be provided. Interposing fixtures shall be used in a manner without filtering out or changing in frequencies ranges from the input motion. The effect of such fixtures and connections must be evaluated and addressed in the report.

6.3 Seismic Aging

Qualification tests on equipment for assessing the seismic aging shall include tests related to the OBE earthquake that will occur prior to the LE. The number of OBEs for any test should be determined based on the tectonic characteristics of site. In any case, the number of tests should not be less than five.

6.4 Functional Tests

These tests are used to control the functionality of equipment during occurrence of an earthquake. The test should be done base on the one of the procedure represented in the section 6.6. The equipment must be subjected to the time history that are compatible with tectonic characteristic of site. There is no need to assess the performance of the equipment beyond the calculated MCE of the site.

6.5 Assembly Testing

The equipment assembly test which is used in gas shut-off system, should be done in a manner similar to the field.

6.6 Testing Procedure

In general the strong ground motion contains various frequencies up to 33 Hz. The used time history should be selected from recorded time histories of earthquakes at the site and shall scale to the desired response spectrum in the appropriate frequency range. The purpose of selecting appropriate time history is to simulate the site condition during an earthquake.

6.6.1 Derivation of Test Input Motion

The selected time history should have the following characteristics:

-The response spectrum of the selected time history should not below of the RRS in any period. The selected earthquake record can be scaled in frequency domain in an appropriate procedure. Implementation of the other scientifically valid procedures are allowed.

-The response spectrum of the selected time history should be obtained for damping ratio of 5% which is comparable with RRS.

-The peak ground acceleration of the selected time history must be larger than the RRS in the period of T=0.

-The earthquake duration should be larger than 15 seconds.

- The frequency content of the selected time history should cover the frequency range of RRS.

- The spectral intensity of selected time history shall be larger than 40 cm/s. In addition, the duration of earthquake after the instance of the SI=40 cm/s should last at least 5 seconds.

6.6.2 Number of Time Histories for Test

At least two time histories which are scaled to the LE spectrum shall be used in test. The number of OBE time histories can vary considering the seism tectonic of the region for which the shut-off devices are installed. However, the minimum number of OBE records shall be 5.

6.6.3 Fragility Test

Fragility test is used to determine the ultimate capability of equipment. Such information may later be used to prove adequacy for a given requirement or application. Variations in the seismic environment have been shown to influence the fragility level of an equipment or system. One such variation is the directional nature of the excitation. In addition, the environment may possess the characteristics of a shock, a transient, or a steady-state vibration. The tests outlined in IEEE Std. 344TM-2013 is performed to establish fragility data using the guidelines of that sub clause for proper application (see Annex C for additional guidance on fragility testing).

7. Acceptance Criteria for Qualification of Shut-off System

The shut-off Main equipment including sensor, digitizer and actuator shall be met the safety requirements of SIL3 According to IEC 61508 AND IEC 61511 Standards, which is selected based on the area risk assessment and capable to shut-off the gas flow during strong motion of selected time history of LE. At the end of excitation, the shut-off system shall be capable to open the gas flow manually.

Permissible leakage rate of gas flow shut-off system after testing is determined based on the safety requirements of NIGC.

8. Documentation

The following information should be provided in the equipment qualification report:

- Comprehensive technical specification of equipment

- Identification of safety devices and relevant circuits which can demonstrate their safety functions, during and after the RRS.

- Typical operational settings ranges for adjustable devices

- Equipment mounting details, including all interface connections

- RRS for the of LE and OBE

- Selected time histories for test (raw and scaled data) in addition with corresponding response spectrums

- A detailed summary of the qualification test

- Test facility information including:

1- Location

2- Testing equipment and calibration

- Test method and procedures including monitoring for operability and acceptance criteria

- Equipment mounting details, including all interface connections

-Test data including functional tests, TRS plots, time histories, PSD or Fourier analysis, coherence checks as necessary, number of OBEs and SSEs applied, duration, etc., the acceleration time history of the input motion with their corresponding response spectrum.

- Test results and conclusions, including statement of any deviation.

- Fragility test documents

- An approved signature and date are required.