



Exploration & Production

GENERAL SPECIFICATION

Drilling & Wells

GS EP FP 262

Organization and Safety during Stimulation Operations

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1. Scope

This document defines the basic principles to be applied when preparing and running stimulation operations, thus providing the safest and most efficient configuration to reach the objectives.

The rules and recommendations set out in this document are primarily issued for high-pressure pumping treatments performed either rig-less, through a permanent completion string, as well as for treatments conducted through a work string / DST string.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
Not applicable	

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	



Total General Specifications

Reference	Title
Not applicable	

3. Foreword

3.1 Preamble

Stimulation treatment is here used as a generic term and gathers in fact all operations related to the reservoir / well bore interface like acidizing, hydraulic fracturing or sand control installations.

As a matter of fact, stimulation treatments are carried out in order to:

- Improve, guarantee or restore well productivity or injectivity by treating the formation and/or cleaning the well conduit with various chemicals (acidizing, gas/water shut-off, scale treatments, etc.),
- Improve well productivity or injectivity by hydraulically fracturing the formation,
- Sustain well productivity or injectivity by installing sand control (gravel pack, frac-pack).

Any successful stimulation treatment creates a highly conductive path or area in the near-well bore region, which then improves the production or injection flow.

Stimulation works on a well are normally carried out by a Contractor operating under the supervision of the Subsidiary. As a result, standard operating procedures should be developed for each type of treatments. Such procedures should be based upon the requirements described in the present general specifications, the purpose of which is to:

- Ensure safe and effective stimulation operations,
- Improve stimulation performance and reduce stimulation treatment incidents,
- Provide data to enable improved diagnosis when incidents do occur,
- Obtain data that can be used to improve materials and methods.

Stimulation treatments can be either conducted through a work string / DST string (gravel pack, high rate water pack, frac-pack, stimulation of an exploration well, etc.) or through a permanent completion string (possible rig-less operation in this latter case).

3.2 Glossary

BHT	Bottom Hole Temperature
CT	Coiled Tubing
DP	Dynamic Positioning
DST	Drill Stem Test
ESD	Emergency Shut-Down
FSR	Flow lines Safety Restraints
HP/HT	High Pressure / High Temperature

ID	Internal Diameter
JRA	Job Risk Assessment
MSDS	Material Safety Data Sheet
PPE	Personal Protective Equipment
PRV	Pressure Relief Valve
RSES	Responsible for Safety and Environment on Site
SCSSV	Surface Controlled Subsurface Safety Valve
SIMOPS	Simultaneous Operations
SOR	Statement of Requirements
SPM	Stroke per minute
SWL	Safe Working Load

4. Definition of responsibilities

4.1 Operational program

As soon as feasible, Geosciences and Drilling & Wells (or Well Servicing) entities of the Subsidiary should jointly establish a statement of requirements (SOR) to define the objectives of the stimulation treatment and the corresponding general operational program.

Once the SOR is approved and issued, the stimulation program is elaborated by Senior Wells Engineers and approved by Drilling & Wells (or Well Servicing) Managers.

Whatever the importance and the size of the job could be, a dedicated stimulation program shall be issued for each well to be treated.

In addition to providing general reservoir data and specific well information (well schematic & completion data, safety concerns (hazards, presence of H₂S, etc.), pressure pumping limitations, etc.), this technical program is required to contain the following items:

- Summary of the sequence of operations,
- General rig up on location and detailed schematics of the equipment lay out,
- Detailed pressure tests program,
- Definition of the fluids & additives (proppant if any) to be used during the treatment, with detailing the fluid mixing & quantities and the QA/QC that needs to be performed by the Stimulation Contractor's crew prior to pump the job,
- Detailed pumping schedule (stage / type of fluid / volume / expected rate / expected duration / expected pressure / displacement volume / etc.),
- Role and responsibilities during the treatment and in case of contingency,
- Procedures in case of emergency situations (surface leak, tubing leak, breakdown of equipment, etc.).

Also, prior to performing a hydraulic fracturing or frac-packing stimulation, a numerical simulation of the treatment is carried out using a Company-approved model (NSI Stimplan 3-D



model). For matrix acidizing stimulation, a numerical simulation using Contractor's Stimulation software (such as StimCADE, Stim 2001, etc.) is recommended.

4.2 Leading and supervision of the operations

4.2.1 Drilling & Wells (or Well Servicing) Entity

The Drilling & Wells (or Well Servicing) entity of the Subsidiary is in charge of the execution of the stimulation operations in accordance with the technical program and the applicable safety rules.

To assist during the first treatments of a stimulation campaign or for a particularly large and/or dangerous job, a Stimulation Specialist could be requested from the Head Quarters, acting as a technical advisor. In that case, he will assist, at the base, the Senior Wells Engineer of the Drilling & Wells (or Well Servicing) entity to prepare the program. On the rig site, he will assist the Drilling & Wells (or Well Servicing) Supervisor to implement the program.

4.2.2 Drilling & Wells (or Well Servicing) Supervisor

A Drilling & Wells (or Well Servicing) Supervisor shall be on the location and be officially in charge of the operational progress of the job on site, from the initial site review and hook-up of the required equipment to the unloading of the well.

In addition, for operations on a producing well, a Production Representative shall be present and be responsible for operating all the production equipment.

The Drilling & Wells (or Well Servicing) Supervisor reports to the RSES for safety and environment matters and he coordinates the actions of the various service companies involved in the operation (Drilling Contractor, HP Pumping, Well Testing, Electrical Logging, etc.).

More particularly, he :

- Supervises the execution of the technical program, with respect to the safe limits,
- Ensures, conjointly with the RSES, that SIMOPS issues and work permit procedures are in line with the SIMOPS safety dossier and the bridging document,
- Supervises the pumping and flow back operations, in coordination with the Stimulation Specialist,
- Supervises the cleaning of the location after the treatment.

4.2.3 Senior Wells Engineer

The Senior Wells Engineer, located at the base, monitors the daily progress of the stimulation operation and ensure its objectives are being met. Necessary program amendments should be prepared and discussed with Geosciences and the Drilling & Wells (or Well Servicing) Supervisor.

4.2.4 Drilling & Wells Superintendent

In case of rig-based operations, the Drilling & Wells Superintendent in charge of the rig and located at the base helps the Senior Wells Engineer on equipment delivery / preparation, logistic issues and communication with the Drilling Contractor.



4.2.5 Stimulation Contractor's Supervisor

The Stimulation Contractor's Supervisor is in charge of all surface stimulation operations on the site. He operates under the direct supervision of the Drilling & Wells (or Well Servicing) Supervisor and provides him with all necessary information for reporting purposes including information on stimulation operations progress, HSE issues, quality control, stimulation equipment status, supplies and logistics, etc.

He ensures that all stimulation equipment is rigged up, tested and operated in accordance with current procedures and the stimulation program.

He is responsible for the quality of stimulation measurements, data collection and reporting, routine inspection and maintenance of equipment, on-the-job supervision and training of personnel, safe operating practices of stimulation crews, toolbox meetings, etc.

5. Organization on site

Stimulation treatments are potentially hazardous because of the high pumping pressures involved, the nature of the injected fluids (toxic, corrosive, energized with compressible gas, flammable, etc.) so as the chemicals handled and the number of people involved.

Depending on their nature, stimulation operations may require a large plot space to allow all the equipment to be placed on site at suitable distances from the well head. Plot size requirements should thus be identified as early as possible in the planning stage.

5.1 Site survey

A site survey carried out beforehand by a Drilling & Wells (or Well Servicing) Representative, together with Production and Safety Representatives, is a must. A survey report should then be issued with correctives actions, if any. This report would allow to list in particular all critical points noticed in the immediate vicinity of the site / well location: access (roads) for equipment and water haulages, other logistical constraints, platform, cellar, pits and flare pit, water well, wind direction, production and gas lift lines, cluster or isolated well, village near the site (if any), risk of pollution, overview of well maintenance history and previous in-the-hole operations.

A layout plan for the spread of the stimulation equipment is then to be provided by the Stimulation Contractor, taking into consideration hazardous areas and ensuring that access is possible for other services, e.g. perforating, coiled tubing, well pressure control equipment, etc.

5.2 Safety perimeter

A safety perimeter is defined, gathering all the HP equipment susceptible to induce projections of pressurized fluid in case of incident or leak: well heads, injection lines, clean-up lines and manifolds. If enough space is available on location, the safety perimeter radius is 30 meters and it is clearly delimited with dedicated barriers and signs.

During the operations, personnel movements are restricted around the pressurized equipment and only the designated Stimulation Contractor's personnel is allowed to circulate within this safety perimeter.

5.3 Operational perimeter

Since they are potential ignition sources for flammable fluids, HP pumps, engines and electrical appliances are excluded from the above safety perimeter. If feasible, they are located at a minimum distance of 30 meters from the well head, inside the so-called operational perimeter.



The stimulation control centre is also located at a minimum distance of 30 meters from the well head and preferably 15 meters away from the HP pumps and the mixing equipment, with a clear view of the whole installation.

Wind direction is obviously to be taken into account to locate the stimulation control centre and the engines. Positioning is done also according to the swinging effect of any parted line. Emergency escape direction and muster point for personnel are defined and indicated.

Suggested lay out schematics for stimulation equipment are presented for both onshore and offshore environments in Appendix 1 and Appendix 2.

6. Equipment

6.1 Well equipment

6.1.1 Integrity of well tubular equipment

The well architecture needs obviously to accommodate the injected fluids and corresponding pressures, so as the stresses and movements induced by the stimulation treatment.

Drilling & Wells (or Well Servicing) entity shall check the initial casing/tubing design and verify that both tubing and casing "as set" cope with the concerned load cases, (leak at upper part of completion tubing / DST string, while breaking down the formation and during a screen-out).

Burst calculations of the tubing are carried out based on the maximum expected pressure in case of screen-out (see part 6).

Collapse calculations of the tubing should also be made, as the tubing could be loaded with gas, with no pressure at surface and pressure in the annulus.

Such calculations should also be made to avoid exceeding the collapse rating of any down hole tools located below the packer (frac-packing case).

Tubing stress analysis, simulating the forces on the tubing during the various operations in the well, should be readily available during the stimulation operations.

6.1.2 Cement quality

Quality of cement is assessed in terms of sealing capabilities. Prior to perform a stimulation treatment, it is so advisable to record a CBL, USIT or equivalent log to get a proper indication of how the cement bond is over the zone of interest.

6.1.3 Down hole safety valve

The down hole safety valve is always a concern when performing stimulation treatments (especially hydraulic fracturing) through a permanent completion: it could be damaged during the treatment and also during the well clean-up operation. In any case, the tubing string should exhibit a fail safe closed type down hole safety valve when the well is naturally flowing.

On a production well, when this valve is wire-line retrievable, it is exchanged with a new valve after the unloading phase. When proppant is used, this valve is chosen for sandy service, low friction loss and easy retrieval.

In case of a tubing retrievable valve, the use of coiled tubing or the installation of a protection sleeve (which is not sealing) may be considered for a damage-free stimulation. Anyway, in case