INSTRUMENT SKID FLEXIBILITY IMPROVES
FRAC JOB DATA ACQUISITION

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ABSTRACT

An instrument skid especially designed for fracturing data acquisition provides operator flexibility and choices that can help reduce costs of data acquisition and recording. The operator interface panel (OIP) associated with the skid can be viewed at the skid or can be remoted up to 250 ft distance from the skid. Information collected can be used by the on-board computer system and displayed on three screens of the OIP, or the digitized data can be communicated to other computer systems that may be on the job.

INTRODUCTION

With the current trend in oil field fracturing services toward increased real-time modeling techniques, the need for data acquisition has become increasingly important. An instrument skid has been developed which consolidates many of the instruments used for monitoring downhole fluid parameters into one package, which is prewired and preassembled for use during fracturing treatments. By having all of the instrumentation packaged in this manner, installation time is reduced, while reliability should be improved.

Figure 1 is a top view of the instrument skid with overall dimensions and the individual instruments labeled. The weight of the unit is about 3500 lbs with a working pressure of 15,000 psi. The height of the skid is about 42 in. not including a removeable accessory basket which is used to transport the necessary cabling to electrically hook the instrument skid to other units which may be on a location.

The 4 in. line is designed to handle the slurry on the down-hole loop, which would be the proppant and the gel system. The 4 in. line contains a 4 in. turbine flow meter, redundant pressure transducers, and a radioactive densometer.

The 3 in. line is designed to accommodate gas flows when a foam frac is employed. The 3 in. line contains a 3 in. turbine flowmeter, temperature transducer, and a pressure transducer.

A third monitor line is employed to measure back pressure on a well when the treatment is down a tubing string. This is a 2 in. system with dual pressure transducers.

COMPUTER MONITORS

The first on-board computer, which is hard wired into all of the monitoring instruments, is called the controller. This unit collects data from each of the instruments and places the information into a format that other computers on the communication network can read.

The second on-board computer, called an operator interface panel (OIP), can be remoted from the instrument skid up to 250 ft. The OIP takes data from the controller and transforms it into a readable unit for visual display. Figure 2 shows the main screen display of the OIP as well as the control buttons used to input information to the instrument skid. This information is put into the number entry panel on the main screen by using the cursor button and the numeric key pad. Once the number has been entered correctly into the number entry panel it can be transcribed to various other panels slots such as stage size by using the appropriate key and the enter key on the panel. In this case the stage size key plus the enter key would transcribe the number from the number entry panel to the stage size panel. The advance plus enter key automatically updates the stage number, the stage start, and transfers stage size and calculates a new stage end and updates the stage total amount.

Tubing pressure, annulus pressure, M flow rate, A flow rate, B flow rate, and density or proppant concentration can be selected for display on the main screen from the second screen of the instrument skid. This will be discussed later.

The lower left hand part of the main screen is a graphic display of the volumetric percentages of proppant, gas, and gel which are being pumped into the well. In addition to the graphic display, the calculated volumetric percentages are placed on top of the graph. The surface internal phase percentage is displayed also. The bar in the lower center of the main screen display is a surface internal phase percent error based on the design considerations of the job with plus indicating surface internal phase percent that is higher than the design set point, and a minus indication being a surface internal phase percent which is lower than the design of the job.

Figure 3 gives the second screen obtainable from the instrument skid OIP; it is arrived at by pressing auxiliary display and zero. The left hand part of the display screen gives data from each of the individual instruments on as many as three instrument skids which might be employed on the job. The fourth column is an average or total column; depending on the type of parameter being measured, flows would be totalized while pressures would be averaged.

An individual pressure or an averaged pressure can be selected from this screen for display in the tubing pressure or annulus pressure square on the main screen display. In a similar way the flowrates in the M, A, and B section of the main screen can be selected. The density or proppant concentration parameter can also be selected in this manner.

The middle portion of the second instrument screen displays data from up to two blenders which are equipped with a compatible computer system. It can be seen that much of the information can be verified since it is measured in various places and various stages during the job. Underneath the blender information portion in the center part of the screen is the selection of the type of gas being used for a potential foam fracturing treatment, or the possibility that no gas is being used. The type of gas used on the job is displayed on the main screen graphical display portion, for example CO_2 or N_2. The right hand portion of the screen is the data from up to 10 downhole pump units which would be equipped with a compatible computer system. At the bottom of the pump truck column the parameters again are averaged or totaled as appropriate with pressures being averaged and flowrates being totaled for the entire number of units which are on line.

The third screen on the instrument skid display is used for calibration of the individual instruments and is selected for any of the up to three instrument skids by pressing display and the number of the skid listed on screen number 2 (Figure 4). Pressure transducers may be zeroed or spanned to compensate for temperature or aging in a transducer and turbine flowmeter factors can be entered to adjust for replacement of parts. This screen may also be used to auto-calibrate the densometer based on the fluid which is known to be in place on the instrument skid at the time of calibration. The lower part of this screen is used for densometer data entry from the calibration slurries which are entered at the time the densometer is built. By using this technique, it is not necessary to bring the entire instrument skid in for a densometer recalibration, but only to enter the new data counts based on the testing to be done on the densometer end device itself.

POWER REQUIRED

Power requirements for the instrument skid are 24 volts DC at approximately 5 amps maximum load. Many of the units which are equipped with compatible computer systems have this power wired to a connector which provides for a rapid hook up to the instrument skid should one of these other units be on location.

JOB HOOKUP

In a typical job setup the instrument skid is envisioned to be in close proximity to the well head. The slurry and gas lines will be run to the instrument skid, through it, and then to the well for commingling. The instrument skid is equipped with conventional iron connection systems in that it uses the style 1502 weco union. However, to avoid impact on the unit itself and possible damage to the various instruments on it a special "no impact" tightening system which allows the generation of up to 2,000 foot pound torque with a 200 lb pull on a 3 ft. bar is used. The special bar is carried with the instrument skid and can be used on both the thread half and the wing half of the connections. The skid can be configured either way, that is, with a thread half looking toward the wellhead or with the wing half looking toward the wellhead. The switch is made by exchanging the two adapter units on each end of the skid; these units are held in place by a clamping system.

TEST RESULTS

The first field tests for the prototype instrument skid are being scheduled as this paper is being prepared.

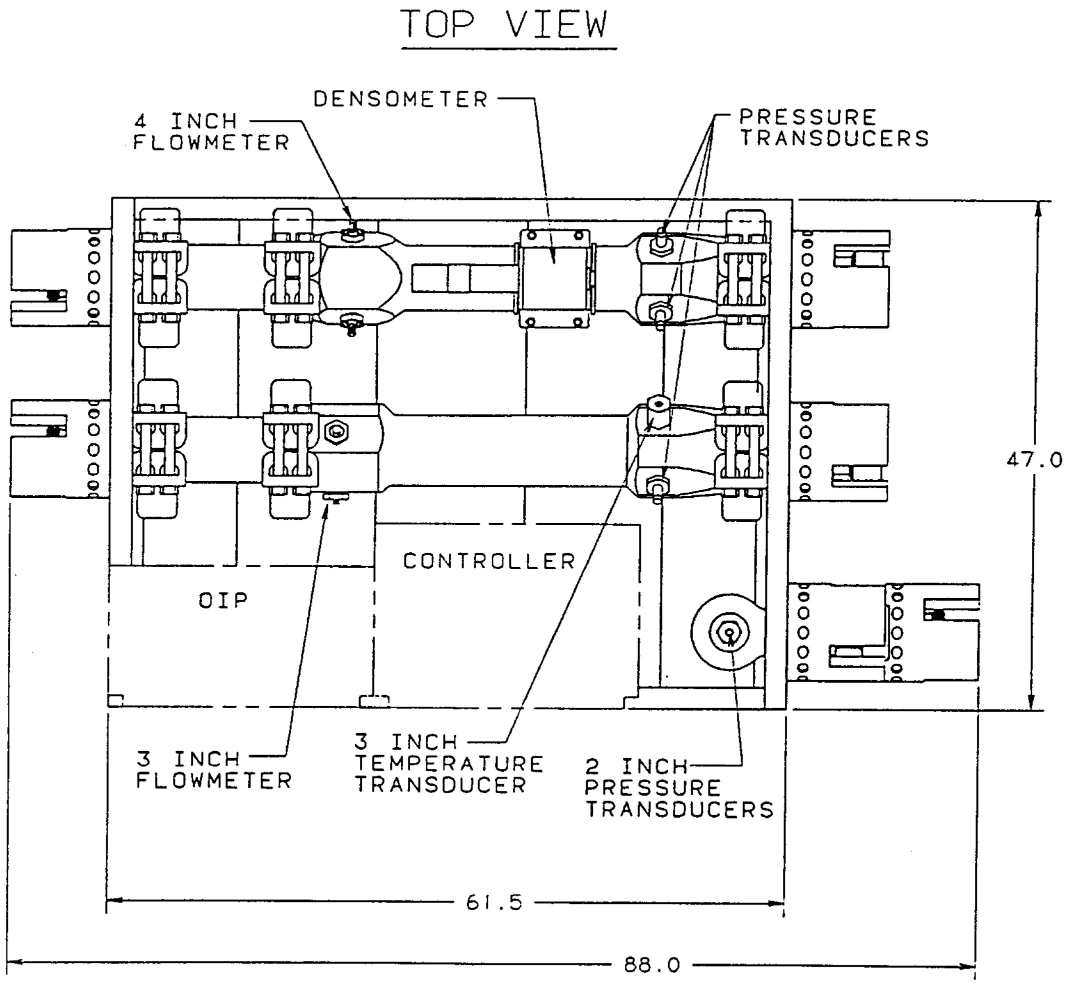

Figure 1 — Instrument skid dimensions and transducers

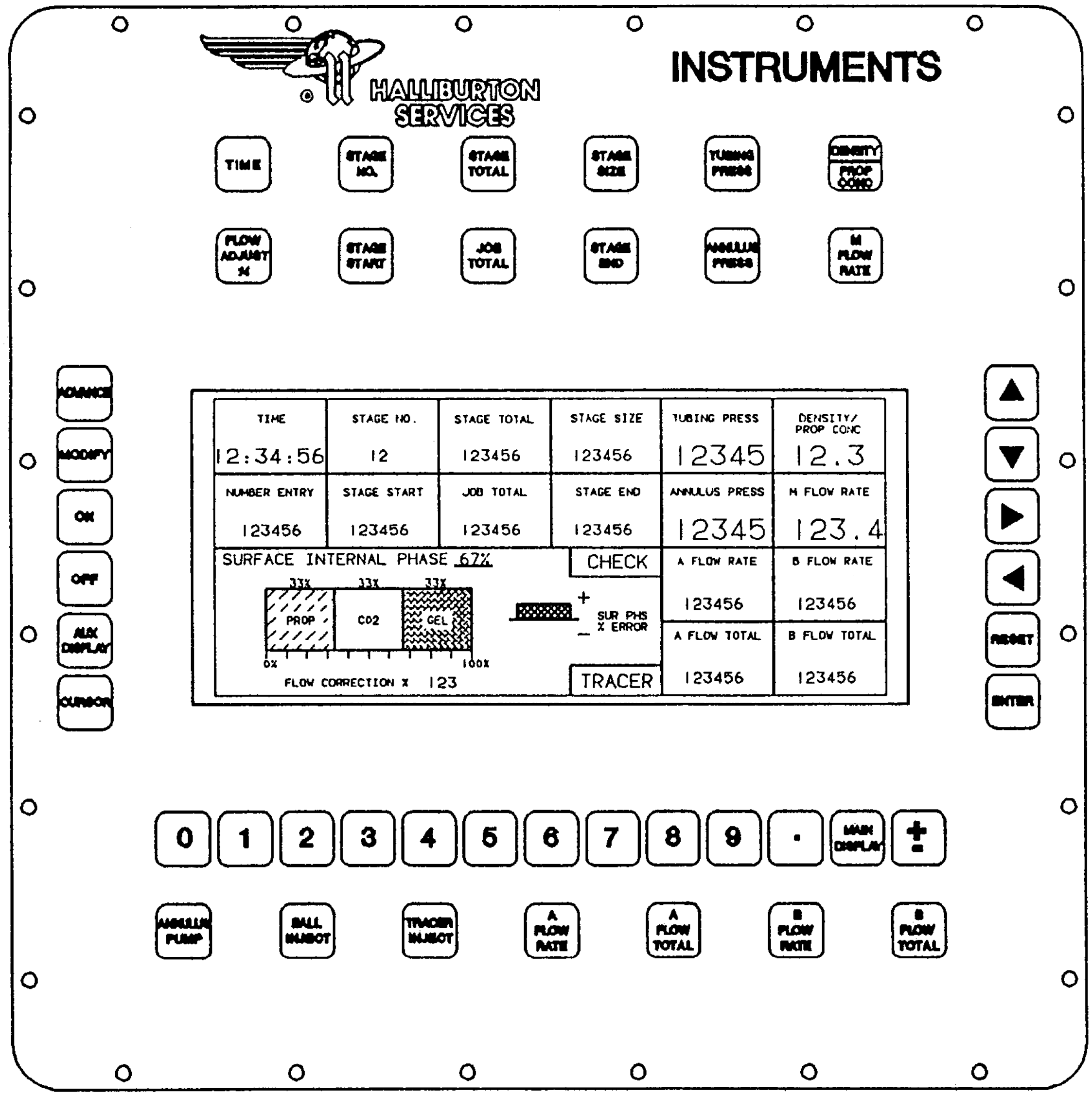

Figure 2 — Instrument skid main screen display

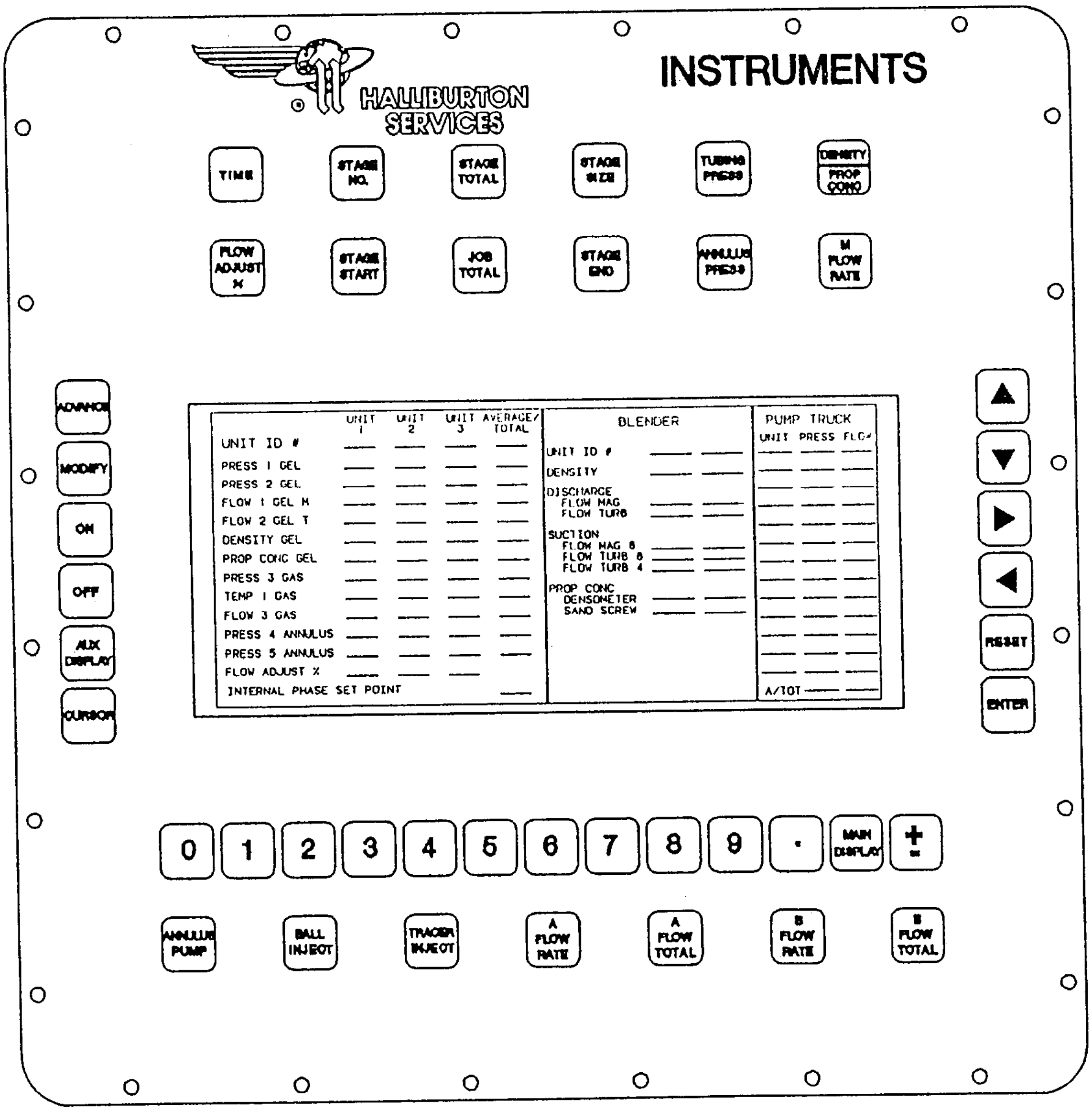

Figure 3 — Instrument skid second screen display

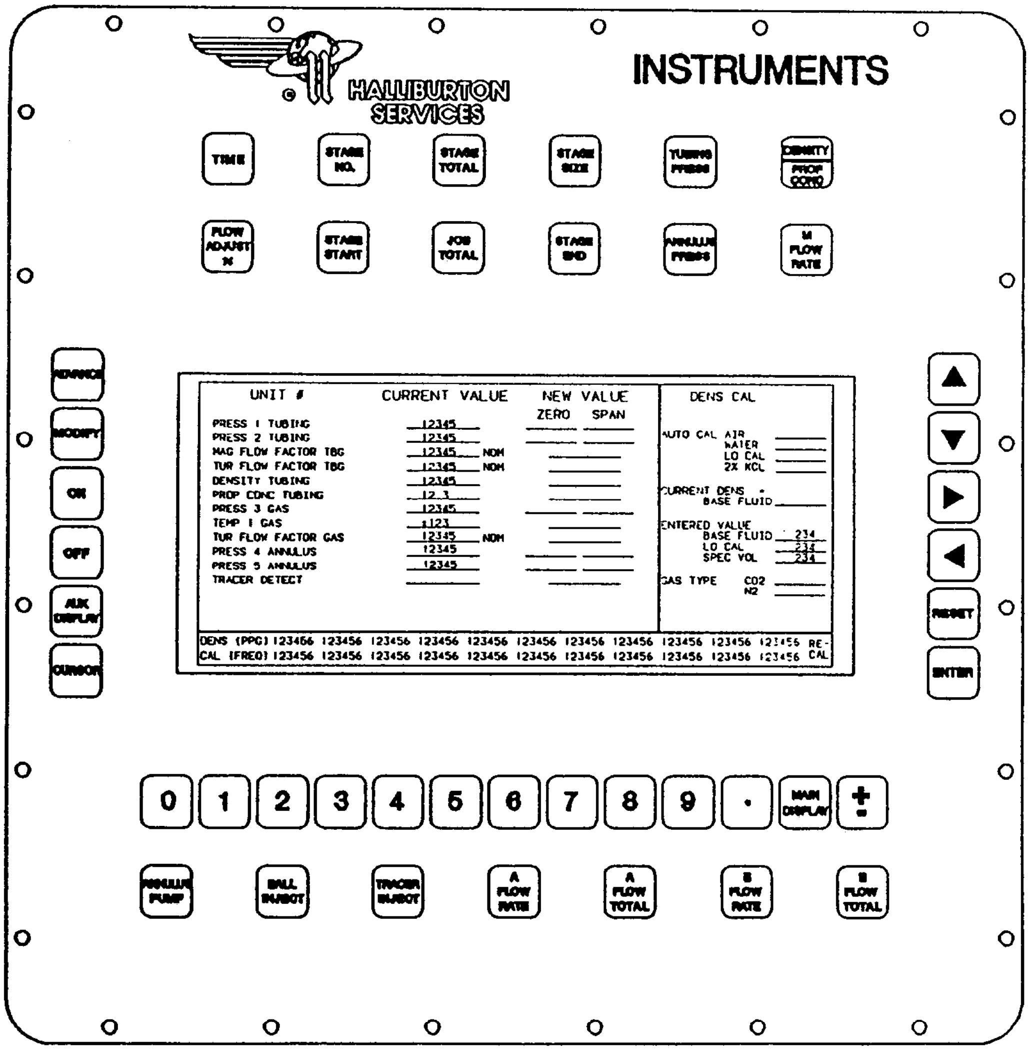

Figure 4 — Instrument skid calibration screen