Bedrock® Open Secure Automation

Pressure Injection Measurement at the Wellhead for Monitoring, Control and Compliance

A Bedrock Automation White Paper

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Underground Injection Control (UIC) Compliance Made Easy

To enhance oil and natural gas recovery, petroleum producers inject high volumes of steam or filtered water into the ground. Safe and continuous monitoring is essential to mitigating risks to underground drinking water and other environmental impacts.

The EPA, under Sections 1421, 1422 and 1425 of the Safe Drinking Water Act (SDWA), has established requirements to protect underground sources of drinking water from endangerment and the state of California has been among the most aggressive in meeting those requirements.

The EPA labels wells that inject fluid to recover oil and gas as Class II wells. Injection of fluids is typically thousands of feet below the surface into rock formations isolated from underground sources of drinking water (Figure 1).

The number of Class II wells that are operating at any one time fluctuates regularly. In 2019, there were around 180,000 in the U.S., mostly in California, Texas, Kansas and Oklahoma. As of April 1, 2021, any of these that have not demonstrated effective underground injection pressure monitoring capability are subject to fines of $25,000 a day. The following is a summary of what well operators must do to be compliant with continuous pressure monitoring requirements as detailed in California Code of Regulations Title 14 § 1724.10.4:

- Implement continuous injection pressure monitoring for as long as the State has approved the well for operation, continuing the monitoring even when you are not injecting pressure.
- At the end of each month, report the highest recorded instantaneous injection pressure that each injection well reached in the most recent preceding calendar month. You can also use digital or analog pressure recording devices to gather and communicate data to send it directly to an information system capable of providing continuous recording. Alarm notification is suggested, but not required.
- Or, instead of the above, demonstrate that you have configured injection facilities to prevent injections from reaching maximum allowable surface injection pressures. (See Appendix 1 – Calculating Maximum Allowable Surface Pressure (MASP)).

Injection pressure records must be maintained for three years after the well is no longer approved to operate.

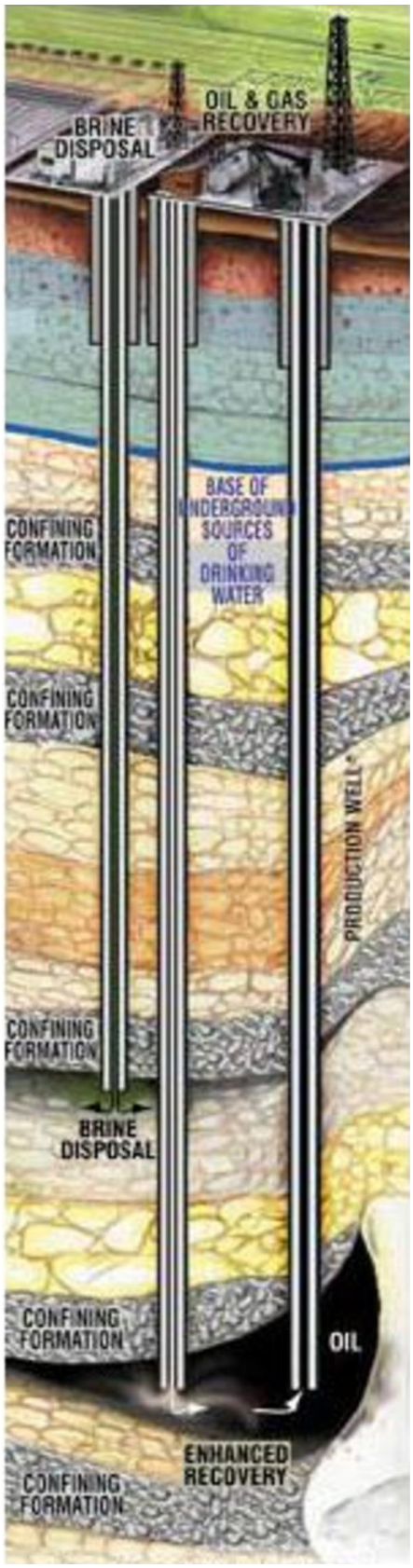

Figure 1: *Typical Class II well strata.*

Compliance fundamentals

Compliance requires the implementation of a system that monitors well-specific pressure operations for pressures exceeding MASP, transmits data for record retention and reporting, and regulates well pressure through automated control.

Figure 2 represents the architecture of a turnkey surface pressure monitoring system. An industrial control system, in this illustration, a Bedrock OSA® Remote, gathers pressure data from pressure sensors located at the injection point and compares readings to the MASP.

Applying this architecture to wells located in remote regions can be challenging and expensive if you have to use a VPN or hardwired connections. Public carriers or TCP/IP based connections may be the least expensive but must be secured.

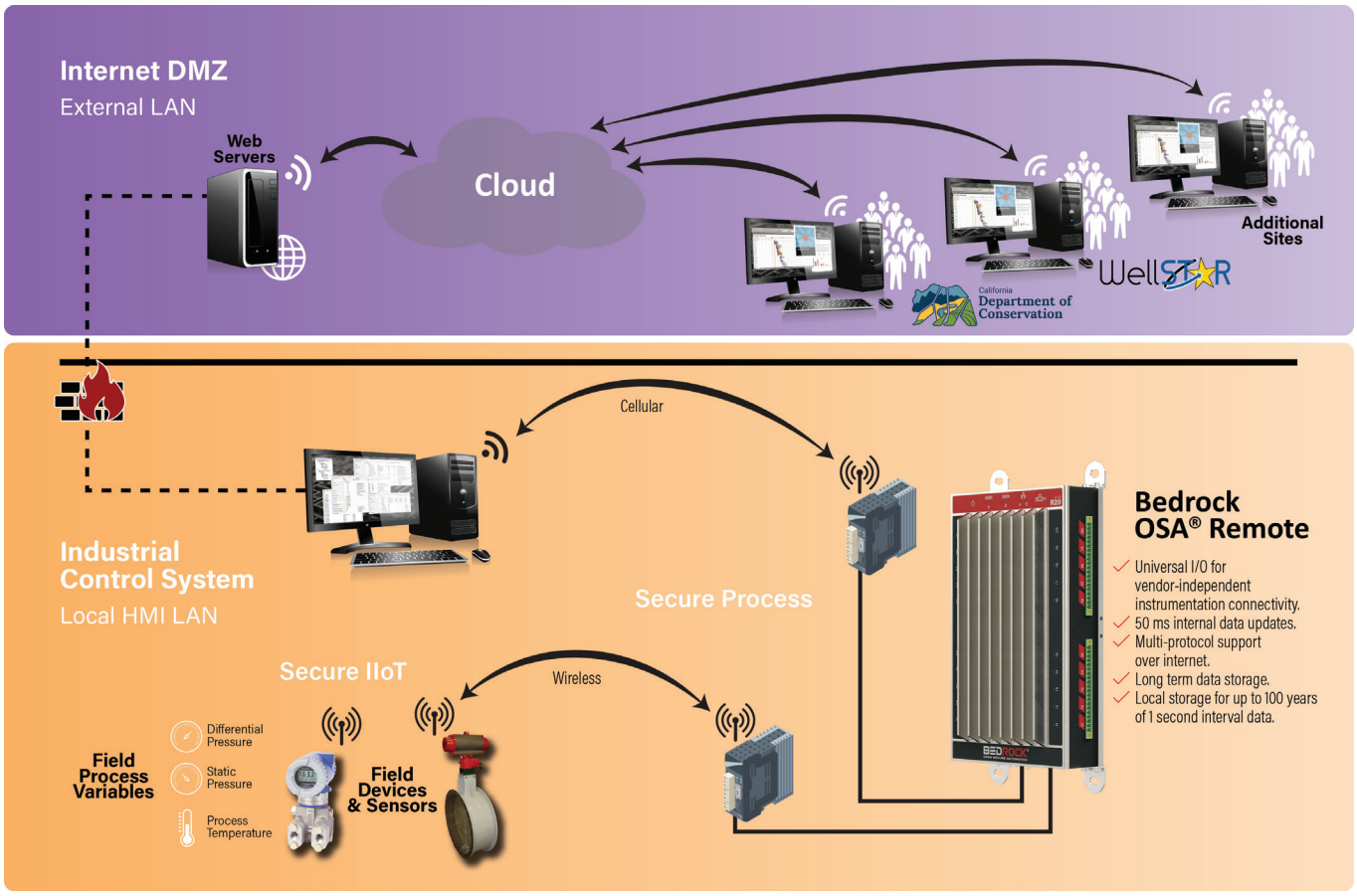

Figure 2: *Turnkey pressure monitoring system.*

Interfacing with the system

Through an interface, an operator will be able to get an instantaneous reading of the pressure and how it is changing in relation to the MASP. Although the law requires reporting on maximum pressure once a month, report by exception can provide instantaneous notification of an anticipated over-pressure event and prevent imposed fines by empowering operations to make corrective adjustments.

Figure 3: *This underground injection control (UIC) monitoring system from Bedrock Automation, provides a turnkey solution for all data monitoring, analysis, control and reporting necessary for compliance with California Code of Regulations Title 14 § 1724.10.4, with the added benefit of wellsite optimization. The Bedrock OSA system has advanced intrinsic cyber security based on TLS and PKI, internet security protocols, to ensure simple, low-cost deployment for remote communications.*

Bedrock's full automation solution

Ideally, you may configure your system for closed-loop control, so that it will automatically adjust valves and other devices to regulate at the proper pressure. If you can demonstrate that you have configured injection controls to prevent injections from reaching maximum allowable surface injection pressures, this could reduce or possibly even eliminate some the reporting and monitoring requirements.

Bedrock documentation and reporting

All acquired data would be stored locally in a user-defined format. This would be accessible through the controller's filing system and stored in the cloud. Local storage of data will ensure that compliance is not dependent on a communication network or cloud services in continuous operation, adding a layer of redundancy and reliability. Compliance communications could be configured locally or at central facilities via the cloud.

In addition to monthly reporting, records of monitoring results must be retained for three years from the day your well is no longer approved to operate by the state.

Reducing cost compliance and optimizing operations

In addition to fulfilling the basic requirements mentioned above, parts of your system design could potentially simplify compliance, lower your cost, improve effectiveness and optimize all injection operations.

If no existing monitoring facilities are in place already, the cost of implementation involves installing electrical, communication and structural infrastructure to enable communication to a SCADA architecture.

Using controls with intrinsic security can lower costs further by reducing the need for extensive add-on protection like firewalls and intrusion monitoring devices.

Turnkey solutions

California regulation 1724 is driving the need of operators for turnkey solutions that are simple to install and operate, and that ensure cost effective compliance. For more details on implementing the Bedrock turnkey Compliance Kit contact solutions@bedrockautomation.com.

APPENDIX 1

Determining MASP

Based on 1724.10.3. Maximum Allowable Surface Injection Pressure

1. The maximum allowable surface injection pressure (MASP) for an injection project must be below the fracture pressure and determined by a step-rate test before sustained injection, in the presence of a CalGEM official. MASP. (14 CCR § 1724.10(i).)
2. Test pressure must be taken from hydrostatic to either the pressure required to fracture the injection zone or the proposed injection pressure, whichever occurs first. Friction loss is not used to determine the MASP but does provide for an additional margin of error for safety.
3. Operators must monitor all injection wells to confirm that injection is at or below the approved MASP on each. If the injection pressure is above the approved MASP, the operator must immediately reduce the injection pressure.
4. Standard Annular Pressure Tests (SAPT) must be performed for each injection well before the commencement of injection and at least once every five years thereafter. (14 CCR § 1724.10(j)(1).)
5. In addition, all injection piping, valves, and facilities must meet or exceed design standards for the maximum anticipated injection pressure and shall be maintained in safe and leak-free condition. (14 CCR § 1724.10(f).)
6. Where there is only a single string of casing across water protected by the U.S. Safe Drinking Water Act (SDWA) (10,000 mg/l TDS or less), the standard annulus pressure test (SAPT) must be tested at the approved MASP for the well. All tests shall be evaluated to ensure casing integrity, i.e., that there are no leaks in the casing and that the fluid is confined to the permitted zone.

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Bedrock Automation intellectual property is protected within the United States and internationally by the following Patents, Patents Pending and Applications as applied within each country.

Canada

Patent No's.	154921, 154938, 154939, 154940, 2,875,515, 2,875,517, 2,875,518, 2,920,133
Application No's.	154921, 154938, 154939, 154940, 2,875,515, 2,875,517, 2,875,518, 2,920,133

China

Patent No's.	104347256, 105680911, ZL201280065564.2, ZL201380079515.9, ZL201380079990.6, ZL201410182071.8, ZL201410799473.2 ZL201430023921.0, ZL201430023931.4, ZL201430023955.X, ZL201430023992.0
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Europe

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Japan

Patent No's.	1504041, 1504042, 1504043, 1509447, 1509675, 6247761, 6352811, 6425984, 6466446, 6584758, 6585334, 6598765
Application No's.	2014-080952, 2014-159475, 2014-243827, 2014-243828, 2014-243830, 2014-550508, 2015-022995, 2015-136186, 2016-021763, 2016-080207, 2016-512039, 2016-533278, 2016-533279, 2016-533280, 2017-237592, 2017-521497, 2018-109151, 2019-087480, 2357/2014, 2358/2014, 2359/2014, 2360/2014, 2361/2014

Korea

Patent No's.	30-778929, 30-778929-1, 30-778929-2, 30-784311, 30-784311-1
Application No's.	30-2014-5754, 30-2014-5755, 30-2014-5756, 30-2014-5757, 30-2014-5758

Taiwan

Patent No's.	D164951
Application No's.	103300684

United States

Patent No's.	8,862,802, 8,868,813, 8,971,072, 9,191,203, 9,436,641, 9,437,967, 9,449,756, 9,465,379, 9,465,762, 9,467,297, 9,600,434, 9,632,964, 9,647,961, 9,727,511, 9,779,229, 9,811,490, 9,837,205, 9,838,001, 9,847,681, 9,940,296, 9,985,789, 10,313,273, 10,534,937, D714,213, D721,706, D721,707, D758,978, D776,630
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Global (PCT)

Application No's.	US2012/72056, US2013/53716, US2013/53718, US2013/53721, US2014/36368, US2015/056538