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Case Study: Chevron, Richmond, California Steam Heater Smart Pig Inspection Using a Header Delivery System

During the spring turnaround in 2016 a header delivery system was used to aid in smart pigging and mechanical cleaning of the steam generation sections of two fired heaters.

Client:	Chevron
Date:	April 5th, 2016
Location:	Richmond, California
Heater type:	Steam generation section of two fired heaters (F-310 & F-311)
Material:	ASME SA-106
Header diameter:	8” SCH 40 (8.625” O.D., .322” thick)
Number of headers:	2 per furnace. 4 total
Tube diameter:	4” SCH 40 (4.5” O.D., .237” thick)
Number of tubes:	6 per furnace. 12 total
Year built:	1965
Date of last inspection:	Never been smart pigged before. Only spot U.T.
Reason for inspection:	The boiler feed water had high hardness levels in 2013 and as part of the follow up to that finding these two furnaces were planned to be pigged to remove any potential buildup from running the hard water through it. Smart pigging of the furnace was also planned to determine wall thickness and ovality of the tubes since the heater has never been fully inspected since it was built over 50 years ago.
Technology description:	A new tool was designed to deliver the smart pigs and the mechanical cleaning pigs without the necessity to cut off the common header or welding flanges onto the tubes. This tool was inserted inside the common headers through the end, and mated itself to the tube to be inspected on each end of the header, thus creating a closed loop system that launchers can be attached to. The tool creates a seal by pressing a custom manufactured rubber seal that is contoured to the inner diameter of the header using a hydraulic cylinder. The tubes to be inspected are located using a high pressure, ruggedized camera which is built into the tool to ensure proper alignment of the tool to the tube.

Case study:

Prior to the development of this custom common header delivery system (HDS), a plan was developed to cut off all 6 pipes from each of the four common headers and weld temporary flanges and U-bends on to them. The flanges could then be used to attach a launcher to each pipe and pigged in a conventional manner. After pigging, the U-bends and flanges would be removed and a new 8" diameter header would be welded back on to the pipes. All welds would require X-ray inspection due to the high pressure steam that is running through the furnace including the temporary U-bends and flanges which were going to be installed. A total of 42 temporary welds and 24 permanent welds where the tubes would be reconnected to the common headers would be required. Access to the bottom of two of the common headers to inspect the welds would also be difficult as the welds are located close to the grating of the platform. If the welds could not be inspected, the grating would have to be temporarily removed for X-ray inspection of those welds.

The common header delivery system required only four cuts to remove one side of the end cap of each common header. The common header did not need to be replaced in this method, and only four welds were required to be X-ray inspected after completion of the job instead of 68 total welds that were required with the original plan. Furthermore, the common header end caps had adequate access for weld inspection and did not require removal of the floor grating. Mechanical cleaning of the heater and smart pigging required a total of 72 hours to complete including all welding and site preparation, which was a 57% improvement in schedule compared to the plan to remove the common headers. Each of the 12 total tubes for both heaters required approximately 1 hour per coil to clean and inspect once the custom tool was set up. Smart pig data on those tubes were delivered within 24 hours after the job completion. The project cost for the contractors was 65% cheaper using the common header delivery system compared to the option of cutting the tubes and welding the temporary flanges and U-bends, and enabled the job to not approach the critical path for the shutdown.

Photos of the original plan and a picture of the common header delivery system tool which was used on the job follow:

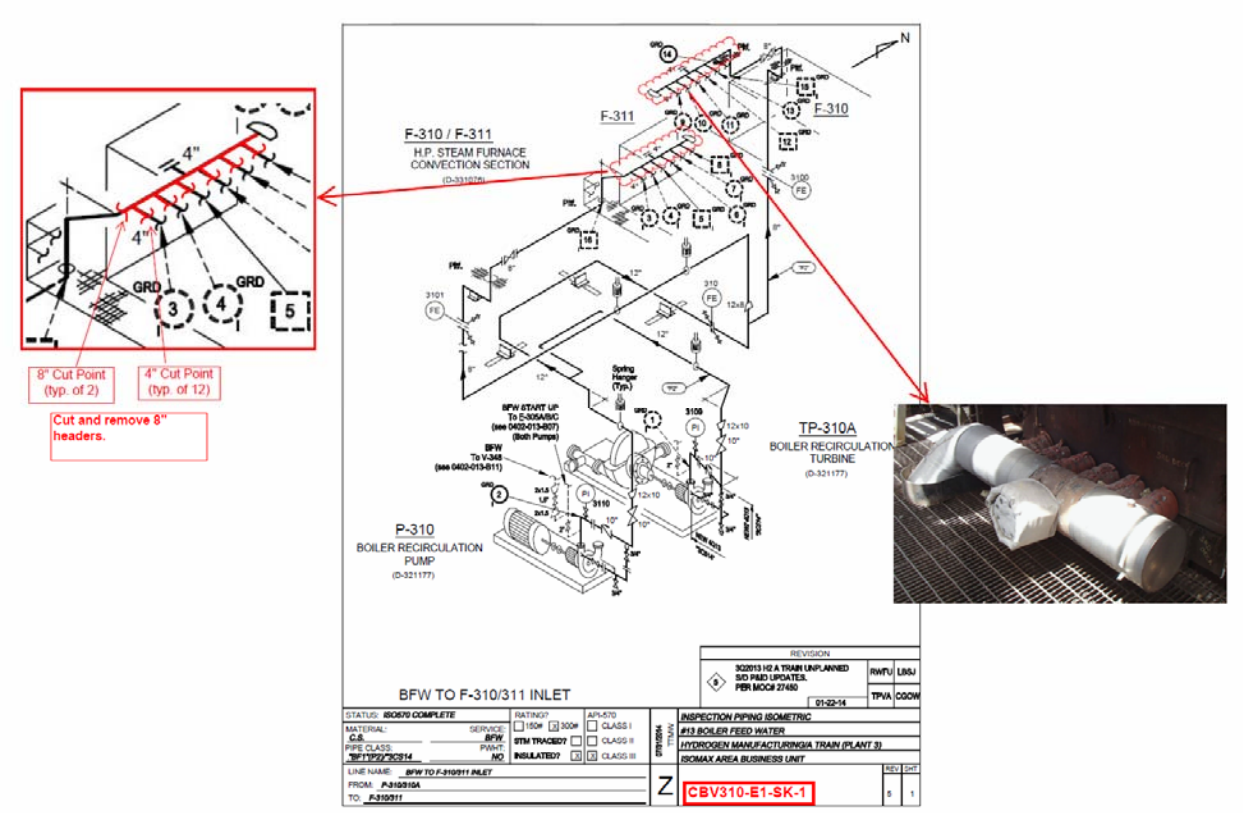

Figure 1: Steam Generator Common Header Removal Plan (Not Executed)

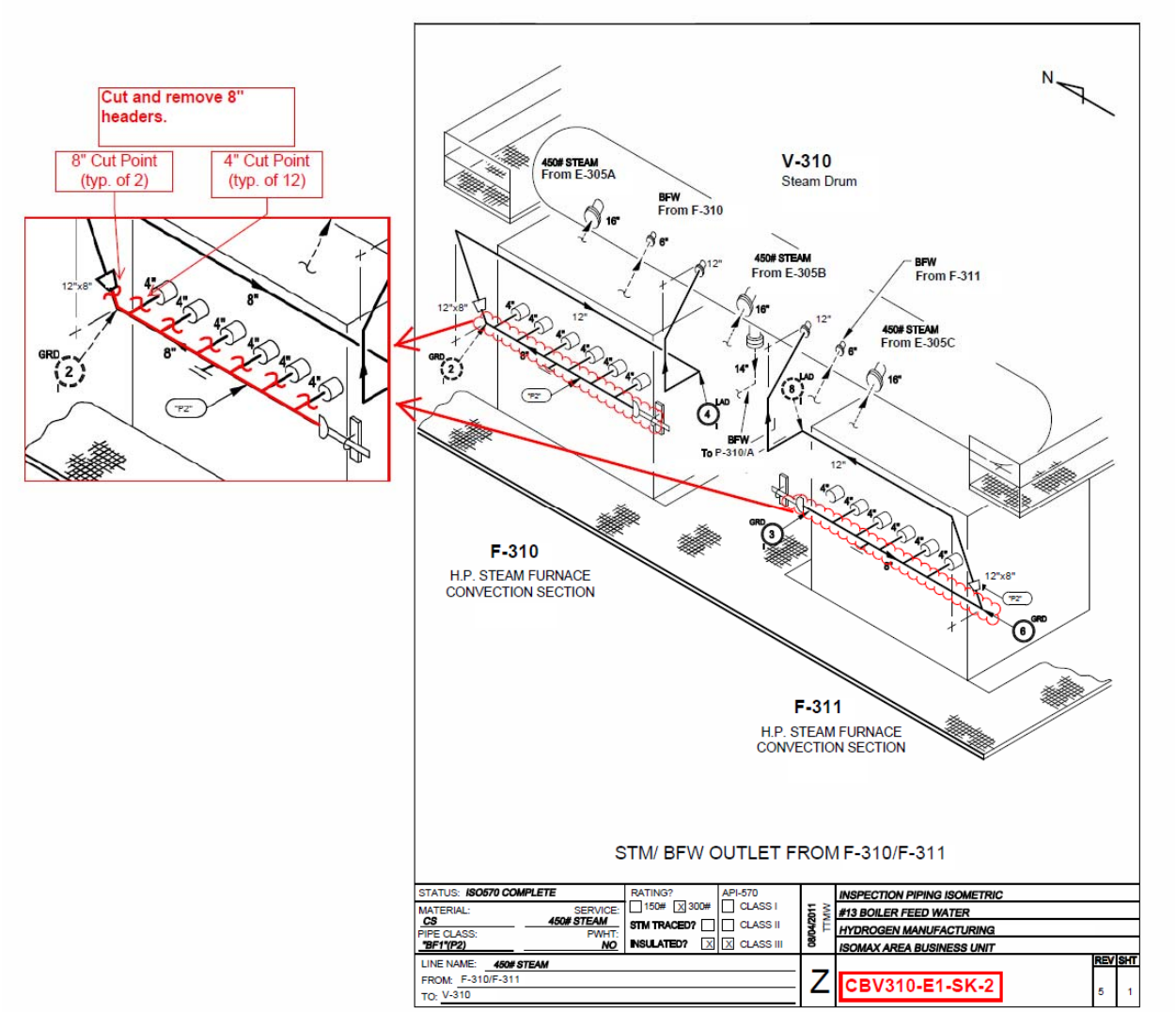

Figure 2: Common Header Removal Plan (Not Executed)

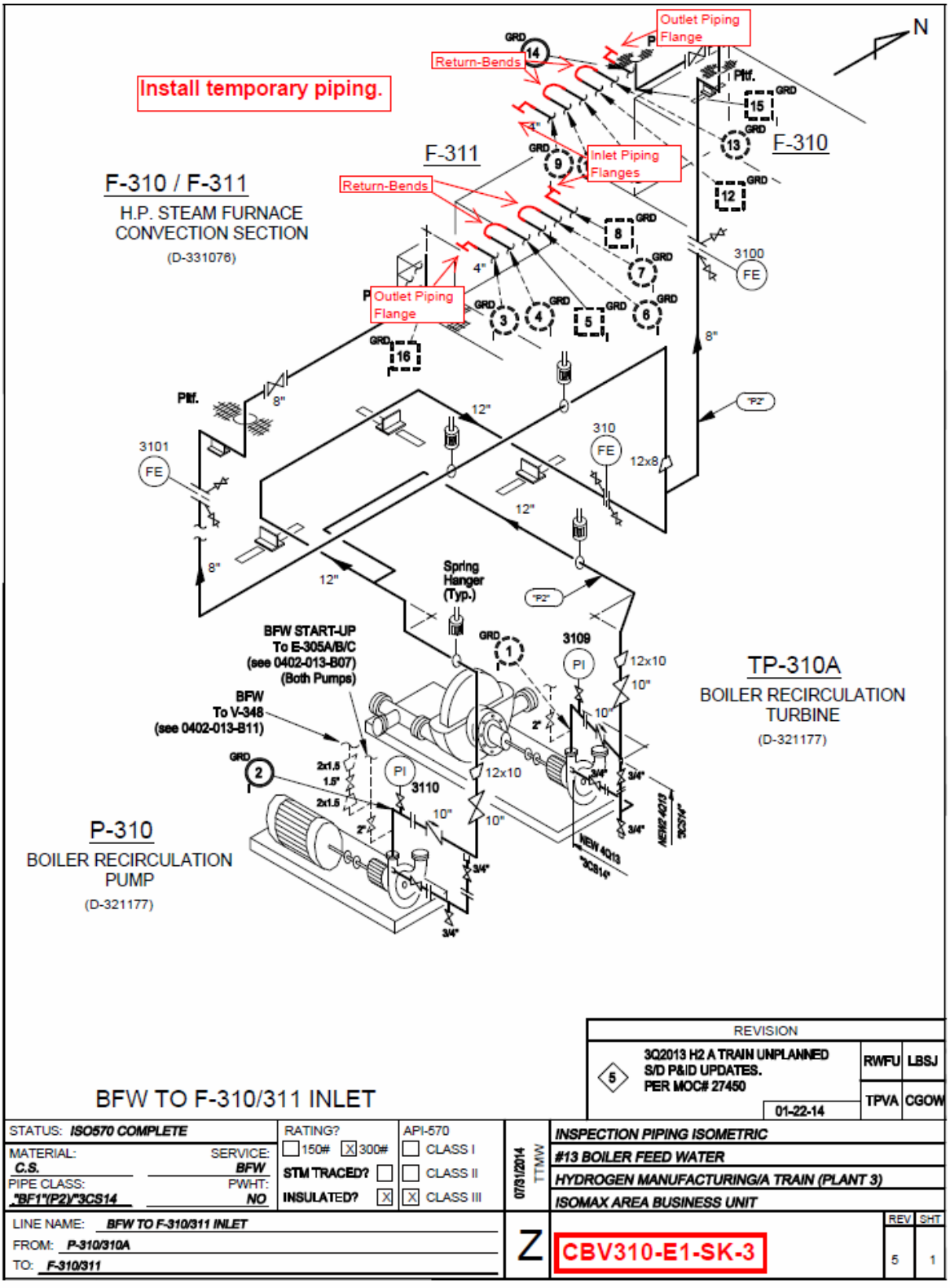

Figure 3: Temporary U-bend and Flange Plan (Not Executed)

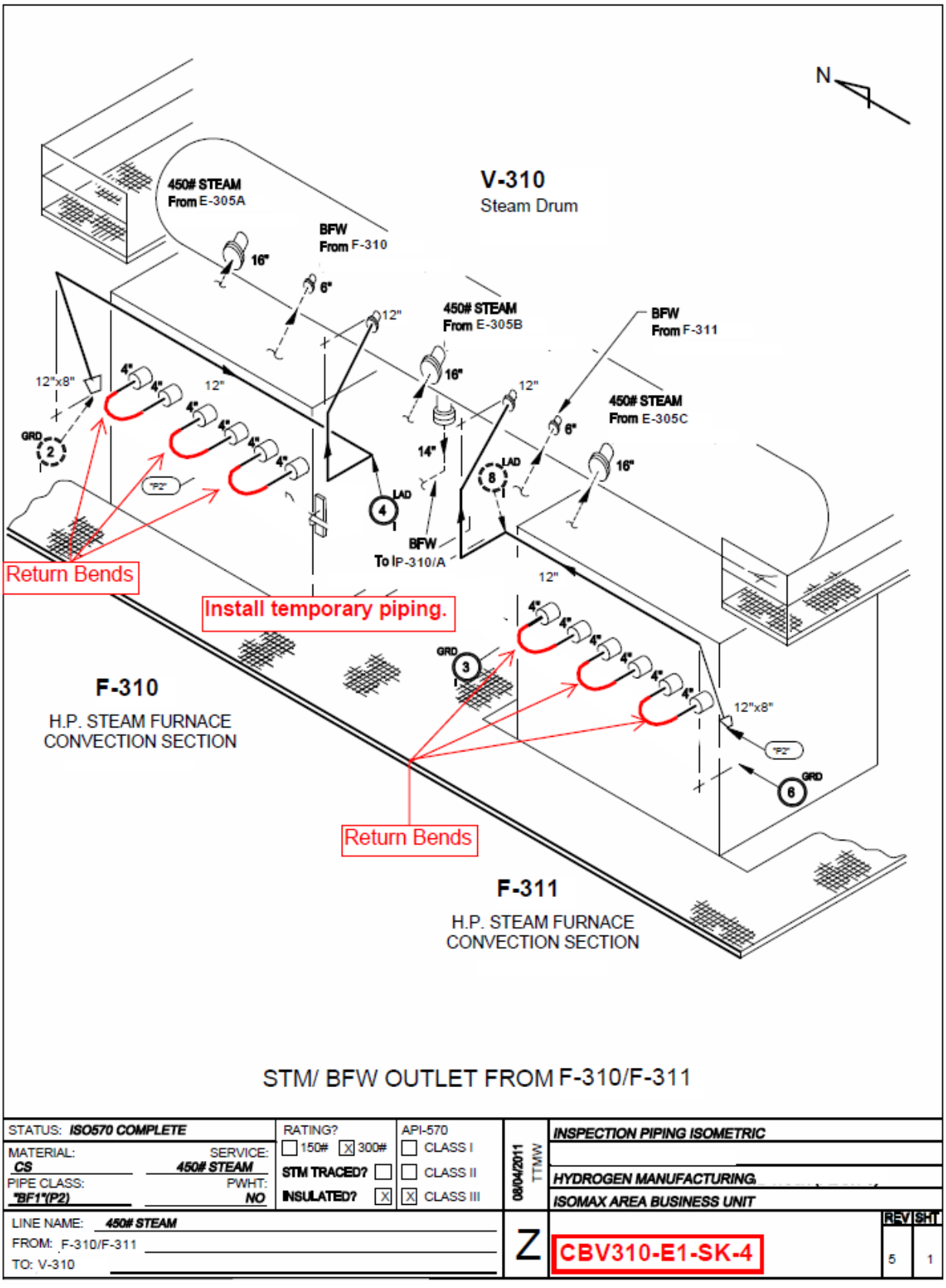

Figure 4: Temporary U-bend Plan (Not Executed)

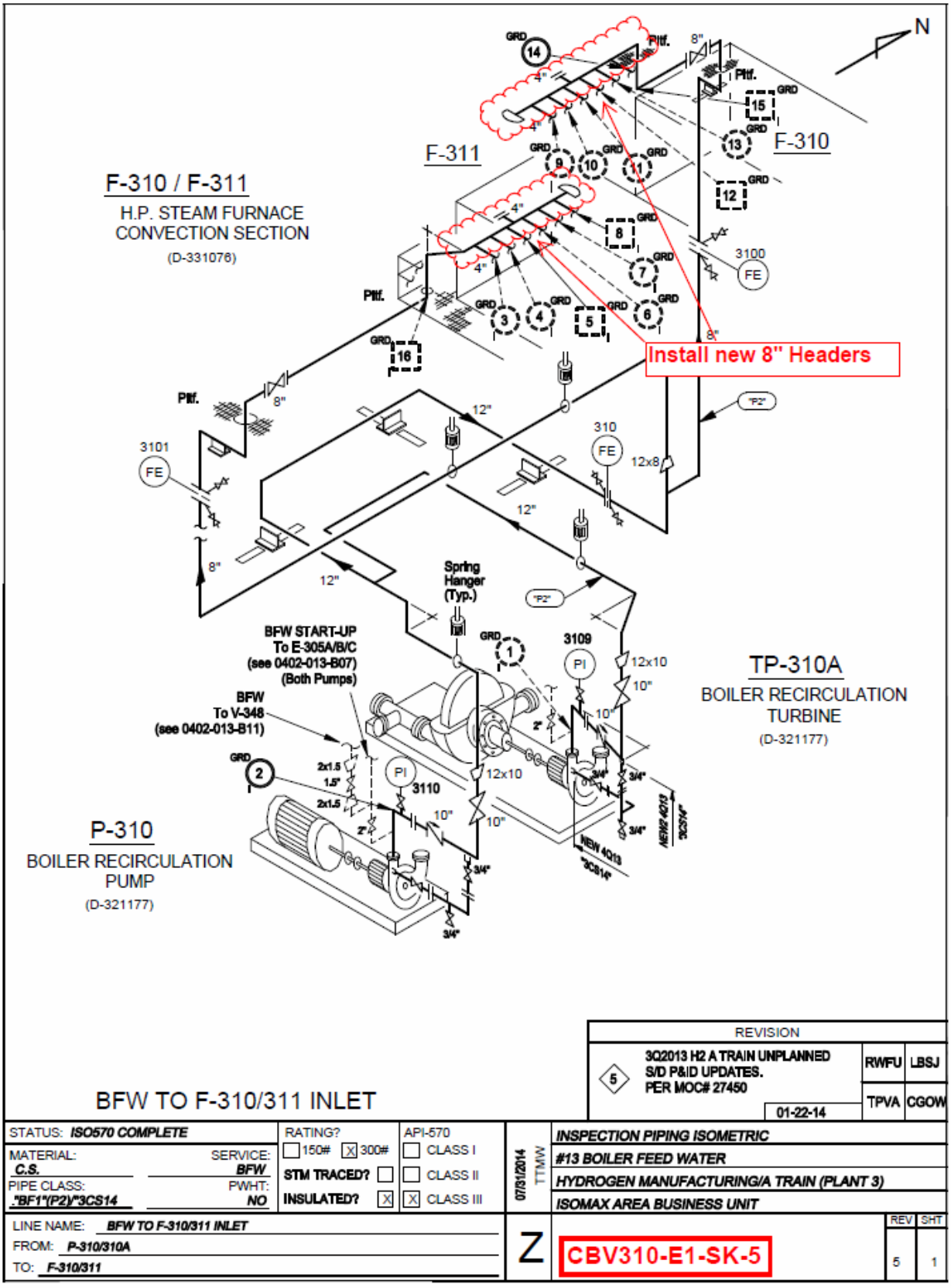

Figure 5: New Common Header Installation Plan (Not Executed)

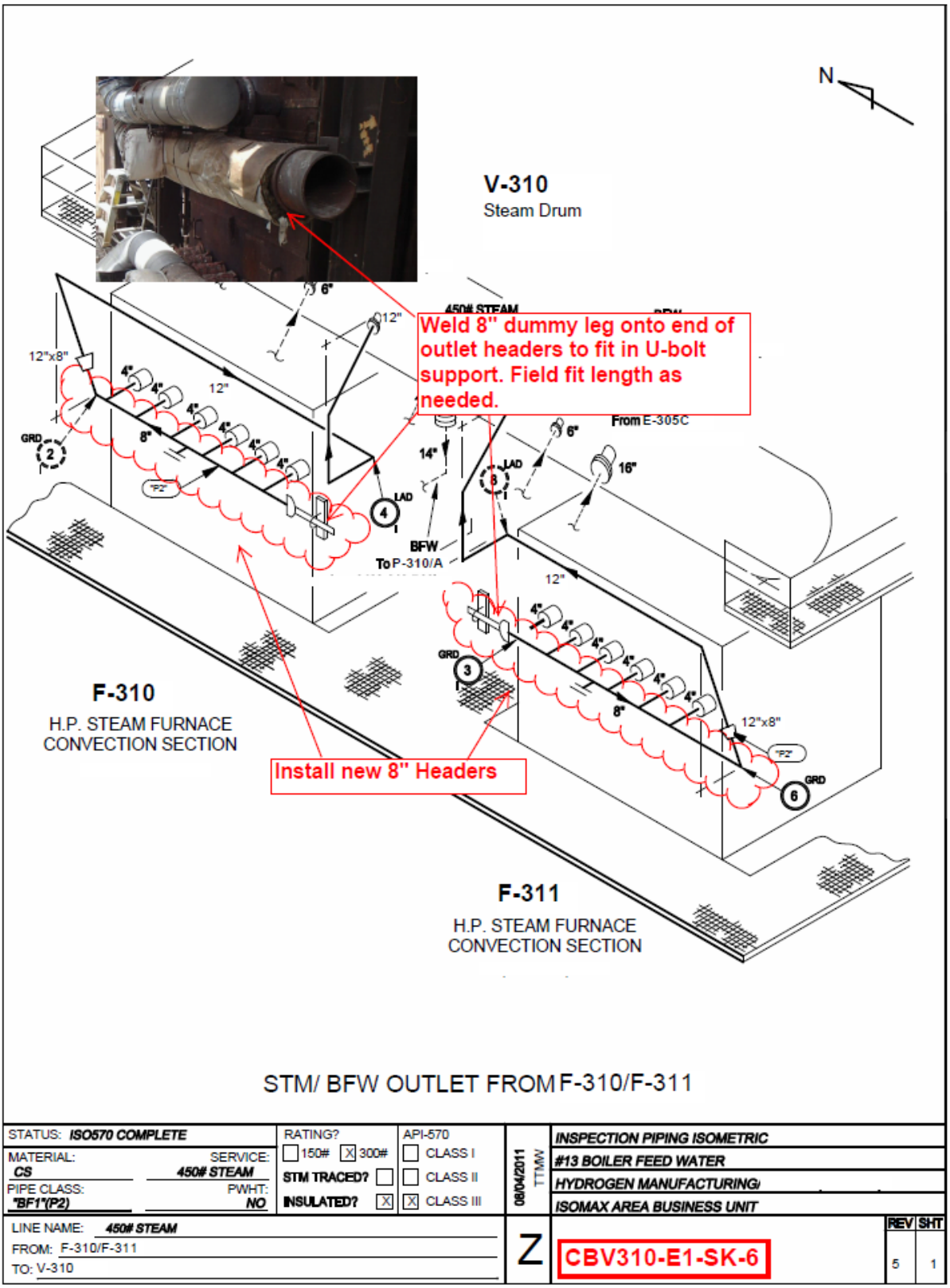

Figure 6: New Common Header Installation Plan (Not Executed)

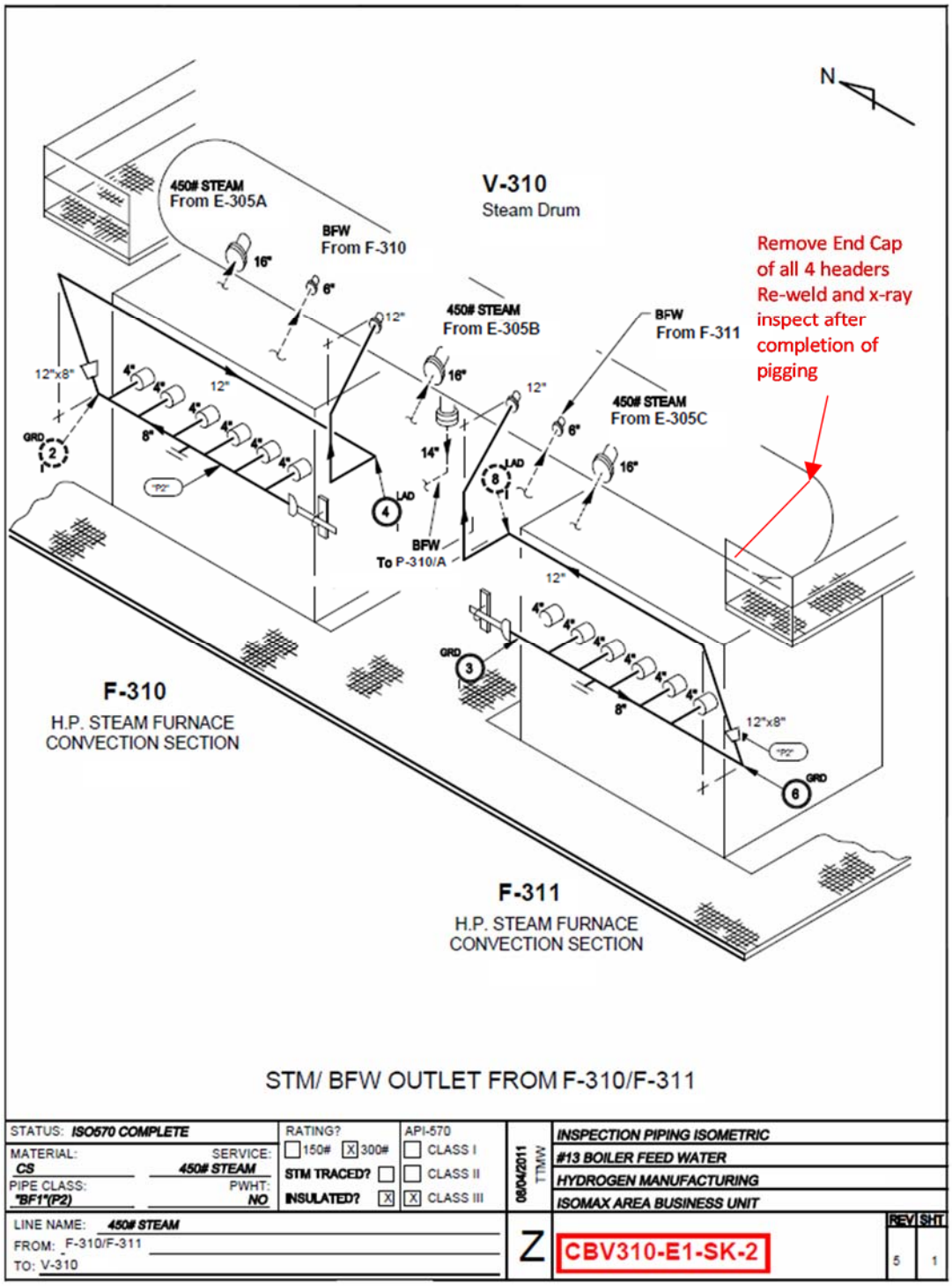

Figure 7: Executed End Cap Cut Plan Using Common Header Delivery Tool

Figure 8: Common Header Delivery Tool

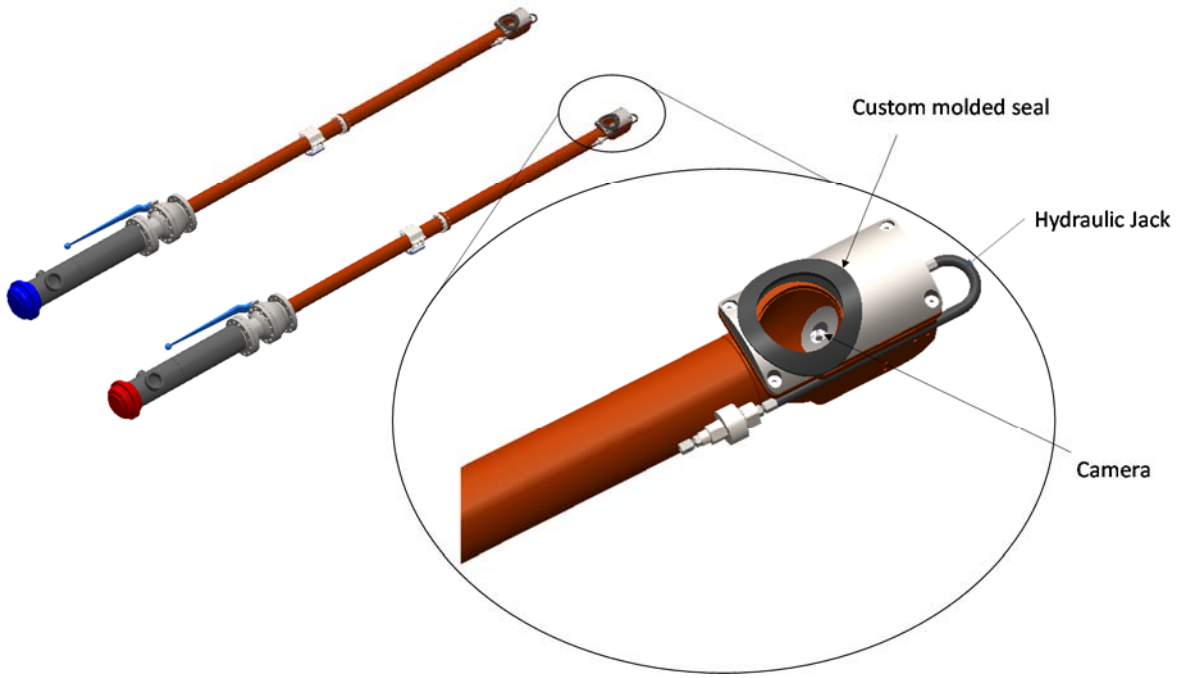

Figure 9: Common Header Delivery System

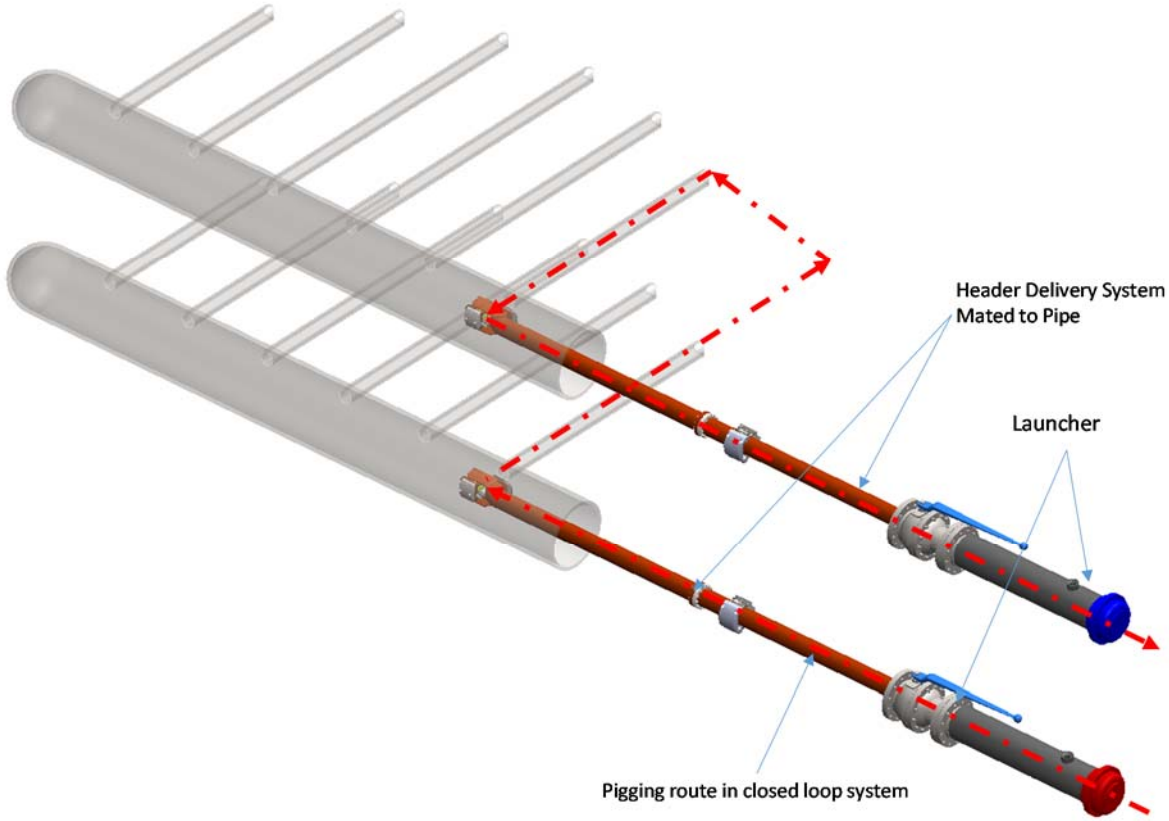

Figure 10: Header Delivery System Installation and Operation