

Guided Wave UT Target Items for Go-No Go Procedures

These target items are for guidance only and do not require that notifications contain only this material. Where operators have alternatives to this guidance, it is suggested that they include it along with any justification in their notification. PHMSA will review each notification on the merits of the individual submittal.

1. Generation of Equipment and Software

The generation of both the equipment and the computer software is critical to the success of the inspection. Both major equipment vendors are on version 3. Prior versions may be used but require operator specific training and procedures for the earlier versions to achieve manually what later versions can do automatically. A Senior Level GWUT Equipment Operator is required for all equipment and software versions, non-automated, prior to version 3 or First Level GWUT Equipment Operator with experience and training in use of the equipment/software version may be used with oversight by a Senior Level GWUT Equipment operator of all procedures used and interpretation of data prior to completing evaluation of data. Automatic diagnostics, etc., may improve the efficiency of the test and reduce the time taken to collect data, but will not affect the sensitivity or ability to detect defects. This allows the operator to focus on the interpretation of the data rather than the mechanics of the inspection.

2. Inspection Range

The inspection range and sensitivity are set by the signal to noise (S/N) ratio but must still keep the maximum threshold sensitivity at 5% cross sectional area (CSA). Any signal that has an amplitude that is about twice the noise level can be reliably interpreted. The greater the S/N ratio the easier it is to identify and interpret signals from small changes. The signal to noise ratio is dependent on several variables such as, surface roughness, coating, coating condition, associated pipe fittings (T's, elbows, flanges), soil compaction, and environment. Each of these affects the propagation of sound waves and influences the range of the test. It may be necessary to inspect from both ends of the pipeline segment to achieve a full inspection. In general the maximum inspection range can approach 60 to 100 feet depending on field conditions for a 5% CSA.

3. Achieving a complete inspection of the pipe

To ensure that the entire pipeline segment is assessed there should be at least a 2 to 1 signal to noise ratio for the required wall loss anomalies to be detected, across the entire pipeline segment that is inspected. This may require multiple GWUT shots. Double ended inspections are expected. These two inspections are to be overlaid to show the minimum 2 to 1 S/N ratio is met in the middle. If possible, show the same near or midpoint feature (if present) from both sides and show an approximate 5% distance overlap.

4. Sensitivity

Sensitivity is defined as the ability to identify a reflection of a specified cross sectional change. The signal to noise ratio determines the detectability at a certain distance and thus sets the range. A sensitivity of 5% of the cross sectional area (CSA) must be achieved. By achieving a 5% sensitivity at the maximum inspection range, a greater sensitivity may be achieved on the segment at locations closer to the inspection equipment. The minimum sensitivity achieved must be able to identify the smallest defects that will fail by rupturing in a hydrostatic test.

The locations and estimated CSA of all metal loss features in excess of the detection threshold shall be determined and reported.

The use of GWUT in the "Go-No Go" mode requires that all indications (wall loss anomalies) above the testing threshold (5% of CSA sensitivity) be directly examined (or replaced) prior to completing the integrity assessment on the cased carrier pipe.

5. Frequency

The frequencies used for the inspections must be in the range specified by the manufacturer of the equipment. A sufficient number of frequencies (at least 3) need to be run for each shot as to determine the best frequency for characterizing indications. The frequencies or range of frequencies needs to be documented.

Different frequencies do not change axial position or clock position. If only a single frequency is selected certain defects may not be detected.

6. Signal or Wave Type – torsional and longitudinal

Most GWUT equipment can provide both torsional and longitudinal signals. Although the use of torsional waves may produce the best results, longitudinal waves may also be considered. Where only one wave type is available, it must be torsional. Documentation of the wave type must be provided.

Torsional waves do not couple well with liquids, therefore if liquid is in or around the pipe segment then the operator must consider the use of torsional waves.

7. Distance Amplitude Correction (DAC) curve is required for each inspection

Setting the DAC curve is an important step in establishing the effective range of a GWUT test and must be performed for each inspection. The DAC takes into account coating, pipe diameter, pipe wall and environmental conditions at the assessment location.

DAC curves provide a means for evaluating the cross sectional area change of reflections at various distances in the test range by assessing signal to noise ratio. A DAC curve is a means of taking apparent attenuation into account along the time base of a test signal. It is a line of equal sensitivity along the trace which allows the amplitudes of signals at different axial distances from the collar to be compared.

8. Dead Zone

The Dead Zone is adjacent to the collar. GWUT uses pulse echo testing. The transmitted signal blinds the received signal, thus reducing the ability to obtain reproducible results. Therefore it can be determined from the length of the transmission pulse and the recovery time of the receiver circuits once the transmission burst has ceased.

Inspection procedures need to account for the dead zone. The length of the dead zone must be documented for each inspection.

Different inspections can yield different dead zones. If one is assessing cased crossings, the collar must be placed such that the dead zone does not extend into the casing, because a majority of indications in casings are typically located within the first few feet. A properly trained service provider can identify and report the dead zone.

To properly assess the dead zone the service provider can move the collar and conduct an additional inspection of the dead zone. An alternate method of obtaining valid readings in the dead is to use B-scan ultrasonic equipment and visual examination of the external surface.

It is recognized that not all manufacturers differentiate between the dead zone and the near field/zone.

9. Near Field Effects

The near field is the region beyond the dead zone where the receiving amplifiers are ramping up in power and thus is the region before the wave is established properly.

This is not a function of the waveform but rather it is a function of the pulse echo collection method and is affected by pipe geometry. Classification is difficult in the near field due to reduced amplitude.

Inspection procedures need to account for the near field. The length of the near field must be documented for each inspection.

To properly assess the near field, the collar must be placed such that the near field does not extend into the casing, because a majority of indications in casings are typically located within the first few feet. A properly trained service provider can identify and report the near field.

To properly assess the near field the service provider can move the collar and conduct an additional inspection of the near field. An alternate method of obtaining valid readings in the near field is to use B-scan ultrasonic equipment and visual examination of the external surface.

10. Coating type

GWUT inspections that have been conducted on pipe coated with coal tar enamel, FBE, wax, extruded coatings, and some with girth welds coated with tape or shrink sleeves, which have not affected results.

Coatings can have the effect of attenuating the signal. Their thickness and condition are the primary factors that affect the rate of signal attenuation. Due to their variability, coatings make it difficult to predict the effective inspection distance.

Several coating types may affect the GWUT results to the point that they may reduce the expected inspection distance. For example, concrete coated pipe may be problematic when well bonded due to the attenuation effects. If an inspection is done and the required sensitivity is not achieved for the entire length of the cased pipe, then the use of GWUT is not feasible and another type of assessment method must be utilized.

11. End Seal

The end seal does not interfere with the accuracy of the GWUT inspection but may have a dampening effect on the range. The vast majority of indications on carrier pipes in casings occur in the first several feet and this area is critical to the integrity of the pipeline. Operators will remove the end seal from the casing at each GWUT test location to facilitate limited visual inspection. Water and debris can collect at the low point and cause electrolytic shorts. Venting can also be a source of moisture and debris, and are typically located near the casing ends. Operators will be required to observe and collect the corrosion data, if found, under the end seal and process the data to verify the GWUT was correct.

12. Weld Calibration – welds are used to set DAC curve

Accessible welds, along or outside the pipe segment to be inspected, are used in setting the DAC curve. A weld(s) in the access hole (secondary area) is an alternative to set the DAC curve. In order to use these welds in the secondary area, sufficient distance must be allowed to account for the dead zone and near field. Having a weld, in the near field or dead zone, between the transducer collar and the calibration weld is not permitted. If the coating is removed from the weld prior to the inspection then the expected attenuation has been changed. A conservative estimate of the predicted amplitude for the weld is 25% CSA (cross sectional area) and can be used if welds are not accessible or version 3 software is being used. Calibrations (setting of the DAC curve) should be on pipe with similar properties such as wall thickness and coating. If the actual cap height is different from the assumed cap height, the estimated CSA may be inaccurate and adjustments to the DAC curve maybe required. Alternative means of calibration can be used if justified by sound engineering analysis and evaluation.

13. Validation of Operator Training

In the absence of an industry standard for certifying GWUT service providers, pipeline operators must require all guided wave service providers to have equipment specific training and experience for First Level and Senior Level GWUT Equipment Operators which include:

1. equipment operation,
2. field data collection, and
3. data interpretation on cased and buried pipe.

A Senior Level GWUT Equipment Operator with pipeline specific experience must provide oversight and approve the final reports of a First Level GWUT Equipment Operator. A Senior Level GWUT Equipment Operator must have additional training and experience beyond that required for the field data collection level operator, First Level GWUT Equipment Operator. This additional training must be specific to cased and buried pipe, and there must be a quality control program which conforms to Section 12 of ASME B31.8S.

Guided Wave Training and Experience Minimums – for First Level and Senior Level GWUT Equipment Operators

- Equipment Manufacturer’s minimum qualification for equipment operation and data collection with specific endorsements for casings and buried pipe
- Training, qualification and experience in testing procedures and frequency determination
- Training, qualification and experience in conversion of guided wave data into pipe features and estimated metal loss (estimated cross-sectional area loss and circumferential extent)
- Equipment Manufacturer’s minimum qualification with specific endorsements for data interpretation of anomaly features for pipe within casings and buried pipe – applicable for Senior Level GWUT Equipment Operator.

14. Equipment – should be traceable from vendor to contractor.

The equipment and software must be readily traceable back to the manufacturer. The version of the GWUT software used and the serial number of the other equipment such as collars, cables, etc., must be traceable and documented in the report. Only individuals who have been qualified by the manufacturer or an independently assessed evaluation procedure similar to ISO 9712 (Sections: 5 Responsibilities; 6 Levels of Qualification; 7 Eligibility; and 10 Certification), as specified above, shall operate the equipment.

15. Calibration, Onsite – diagnostic test on site and system check on site.

The equipment must have been calibrated per the equipment manufacturer’s requirements and specifications for both performance and time between calibrations prior to being shipped to the service provider. A diagnostic check and system check shall be performed on-site and each time the equipment is relocated. Where on site diagnostics show some discrepancies with the manufacturer’s requirements and specifications, the testing shall cease until the equipment can be restored to manufacturer’s specifications.

16. Use on shorted (either direct or electrolytic) casings

Shorted casings may not interfere with GWUT assessments. Guided waves are stress waves or mechanical vibrations in the pipe wall. They are not effectively coupled to and hence should not be affected by the electro-magnetic waves. There may be a reflection if the casing and pipe are in direct contact with high contact force, which may affect the GWUT results, but this can and should be addressed with procedures for any heavily loaded support.

Shorted casings may not interfere with the GWUT signal to noise ratio and subsequent results. If GWUT Service Operators see any evidence of interference other than some slight dampening of the GWUT signal from the shorted casing, it must be cleared to use GWUT.

All indications (wall loss anomalies) below the testing threshold (5% of CSA sensitivity) meeting the GWUT “Go-No Go, 18 Point Checklist” criteria, provided that there is no interference or masking of these indications (wall loss anomalies) if the indications are in the area of the short, do not need to be directly examined.

All shorted casings found while conducting GWUT inspections must be addressed by the operator’s SOPs and are not to be considered part of a GWUT procedure.

17. Direct examination of all indications above the testing threshold is required.

The use of GWUT in the “Go-No Go” mode requires that all indications (wall loss anomalies) above the testing threshold (5% of CSA sensitivity) be directly examined (or replaced) prior to completing the integrity assessment on the cased carrier pipe. If this can not be accomplished then the use of GWUT is not considered feasible and alternative methods of assessment (such as hydrostatic pressure tests or ILI) must be utilized.

18. Timing of direct examinations of indications above the testing threshold.

All indications (wall loss anomalies) that are identified above the threshold must be scheduled for direct examination. Under a prescriptive plan for these indications, the maximum time frame for each is 6 months for those pipelines operating at greater than 30% SMYS and 12 months for those operating at or below 30% SMYS. For those locations where the operating pressure is greater than 50% SMYS, the pressure must be reduced to 80% of the operating pressure at the time the indication is “discovered” by the GWUT. For those locations where the operating pressure is greater than 30% and less than or equal to 50% SMYS, then the operating pressure shall not exceed the operating pressure at the time of the “discovery” of the indication and the monthly leak survey shall be performed until the indication is directly examined. For those locations where the operating pressure is less than or equal to 30% of SMYS, the casings must be leak surveyed once a month until the indication is directly examined.

GWUT Criterion	Required Pipeline Response		
	Less than 30%	Over 30 to 50% SMYS	Over 50% SMYS
Over 5% CSA and identified for examination	Interval < 12 month	Interval < 6 months	Interval < 6 month
	Leak survey once /month	Direct Examination +	Direct Examination +
	Direct Examination	MOP < psi @ discovery	Reduce to 80% MOP @ Discovery
		Leak survey once /month	